

[54] **APPARATUS FOR AUTOMATIC PRODUCTION AND TRANSPORTATION OF FLASKLESS SAND MOULDS IN METAL CASTING**

[76] Inventor: **Eugen Buhler**, Weg zur Walk 96, Burtenbach, Kreis Gunzburg, Germany

[22] Filed: **Jan. 8, 1971**

[21] Appl. No.: **105,067**

Related U.S. Application Data

[62] Division of Ser. No. 753,640, Aug. 9, 1968, Pat. No. 3,566,196.

[30] **Foreign Application Priority Data**

Aug. 18, 1967 Germany..... P 15 83 526
Apr. 27, 1968 Germany..... P 17 58 245.5

[52] U.S. Cl..... **164/160, 164/173, 164/202, 164/243**

[51] Int. Cl..... **B22c 15/24**

[58] Field of Search 164/20, 22, 37, 40, 164/160, 172, 173, 180, 182, 187, 27, 29, 200-202, 207, 210, 212, 237-243

[56] **References Cited**

UNITED STATES PATENTS

3,229,336	1/1966	Hunter et al.....	164/200 X
3,008,199	11/1961	Jeppesen.....	164/22
2,789,325	4/1957	McKee.....	164/202
2,908,951	10/1959	Melka.....	164/207 X
2,672,664	5/1954	Sudziarski.....	164/207 X
2,636,231	4/1953	Dougherty.....	164/22
3,293,703	12/1966	Taccone.....	164/160
3,293,370	4/1952	Roncercay.....	153/212

2,894,299	7/1959	Buhler.....	164/239
3,273,207	9/1966	Taccone.....	164/40 X
3,540,516	11/1970	Taccone.....	164/29 X

FOREIGN PATENTS OR APPLICATIONS

868,409 5/1961 Great Britain..... 164/160

Primary Examiner—J. Spencer Overholser

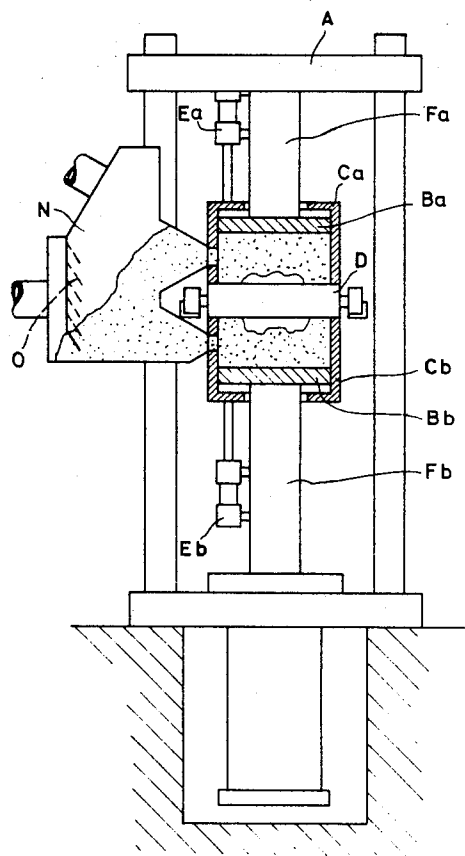
Assistant Examiner—John E. Roethel

Attorney—Holman & Stern

[57] **ABSTRACT**

In a machine for producing and conveying horizontally divided flaskless sand molds, two mold frame cavities are formed above and below a match plate having a pattern on both sides and being movable along horizontal guides relatively to the cavities which are defined by vertically moving mold frames and vertically moving press dies co-operating with said mold frames. The molding sand is introduced pneumatically into the cavities through apertures in the dies and thereafter pressed by a corresponding relative movement between said press dies and match plate, after which the match plate is separated from the mold halves by a corresponding relative movement between the press die and the mold frame on one hand, and the match plate on the other. The match plate is then moved laterally into a rest position and the mold is closed, if necessary, after the insertion of cores. The finished closed mold rests on the bottom press die which is substantially flush with the upper edge of the lower mold frame, and is then displaced laterally from the molding position by the match plate as it returns from its rest position. The ejected finished mold is added to a mold train, and the finished mold is at least supported on two sides by supporting means.

33 Claims, 27 Drawing Figures



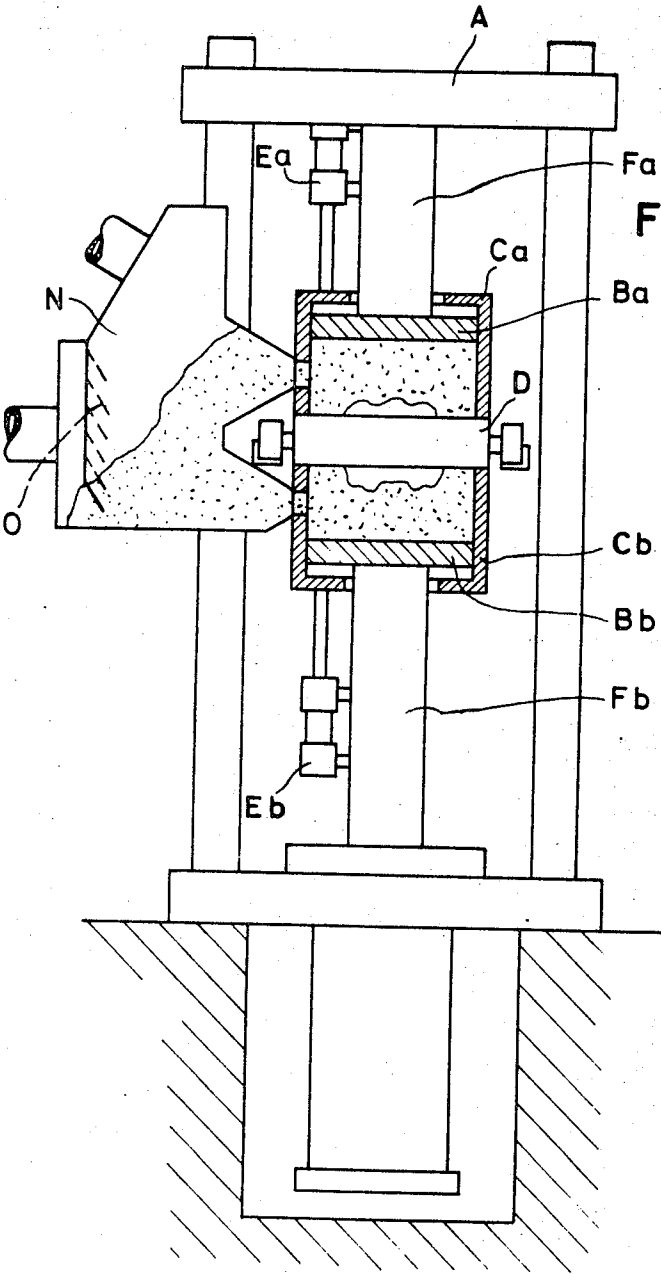
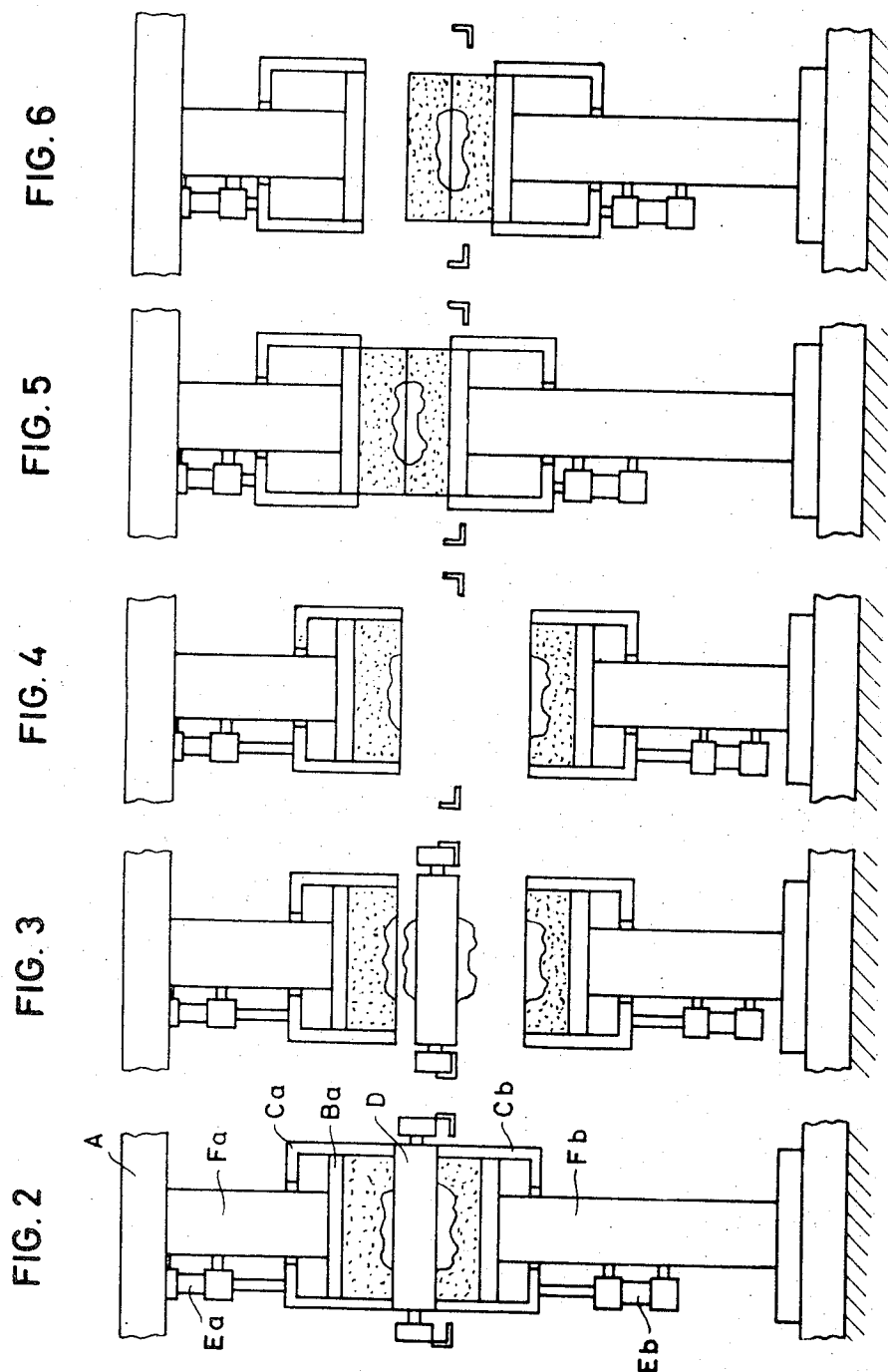


FIG. 1



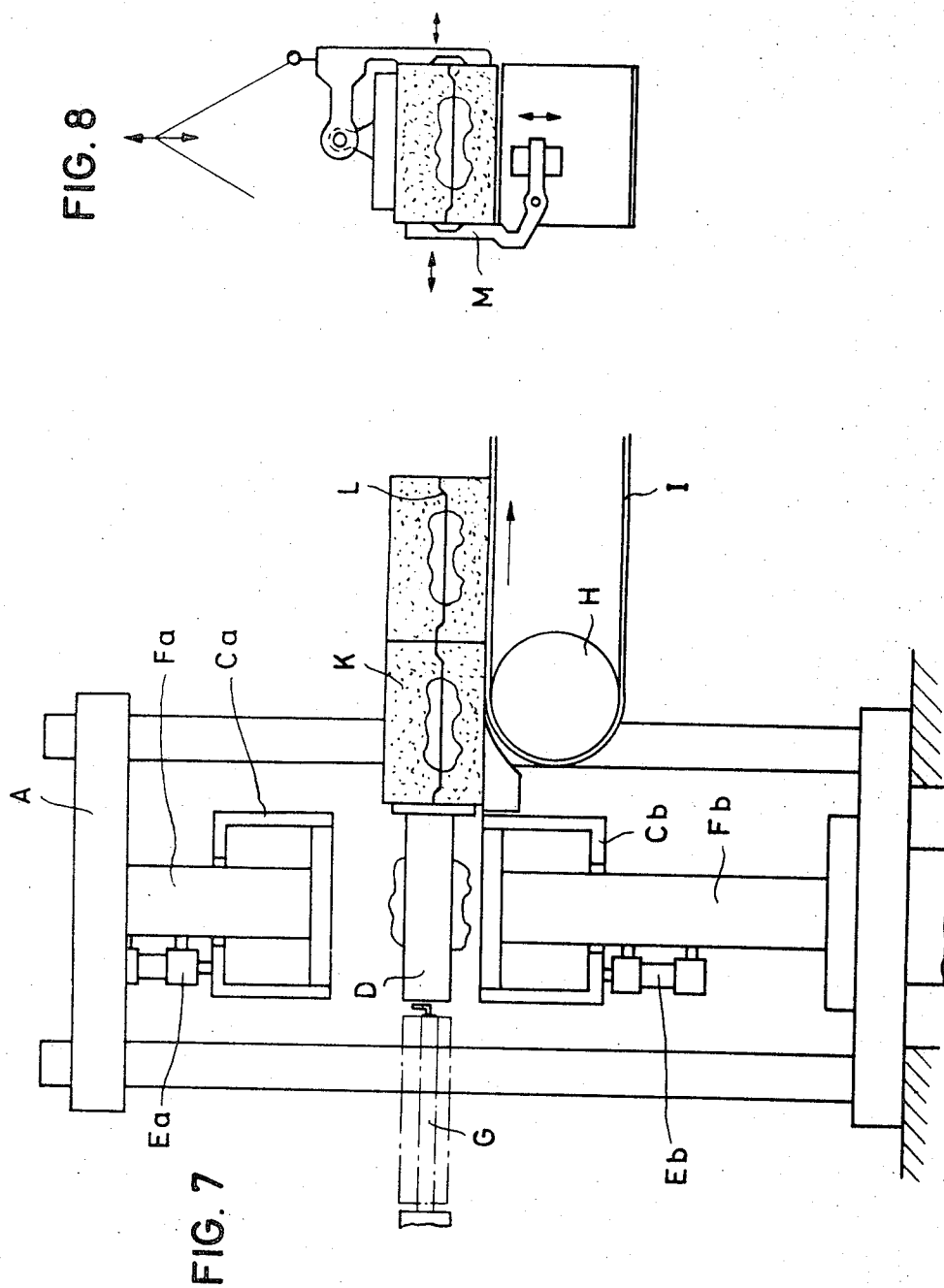


FIG. 10

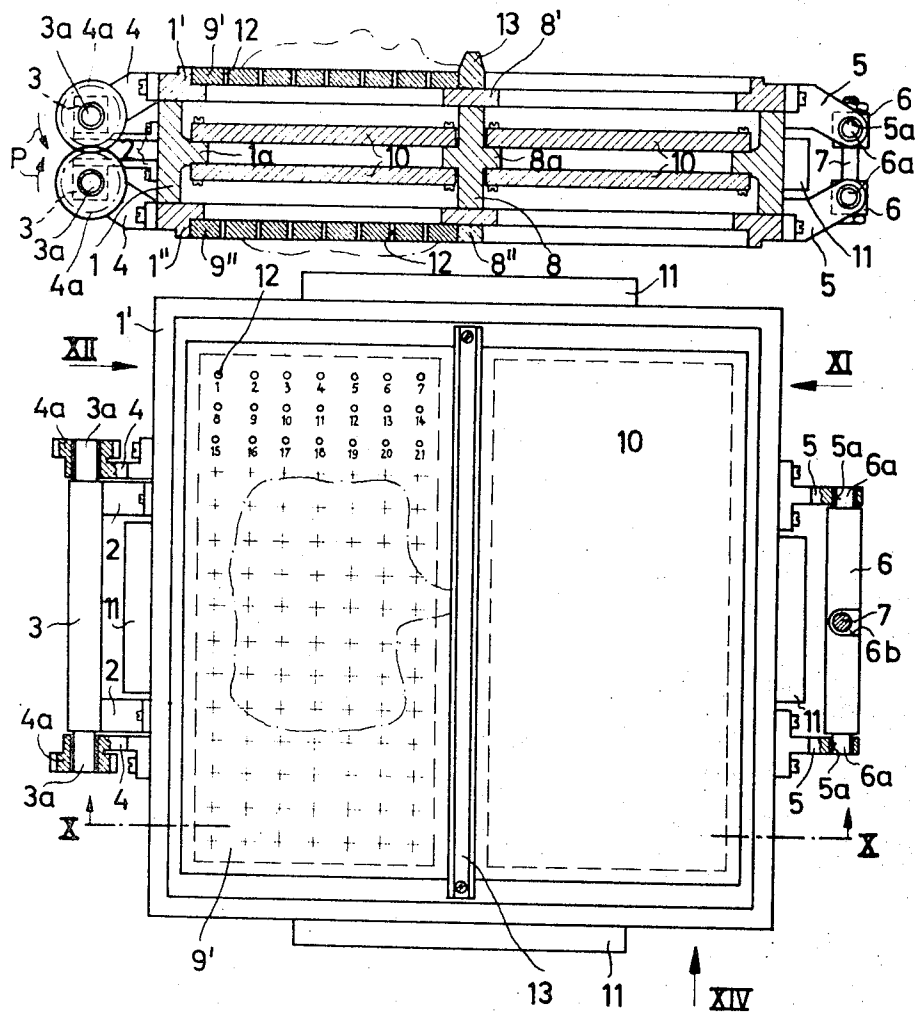


FIG. 9

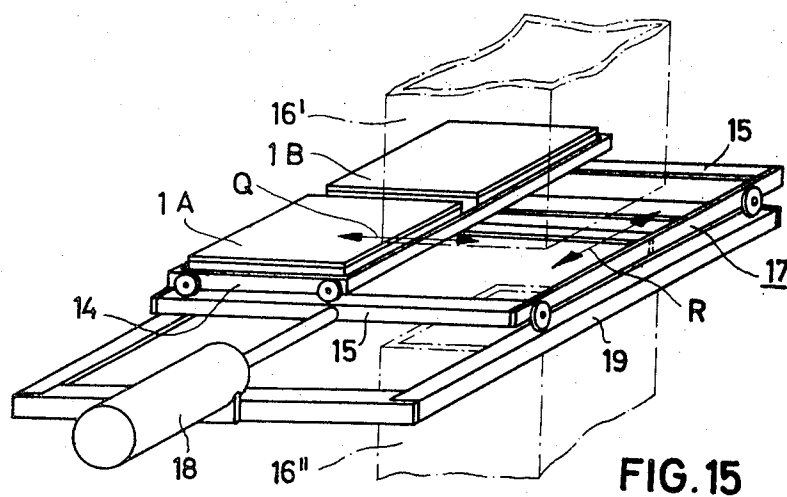
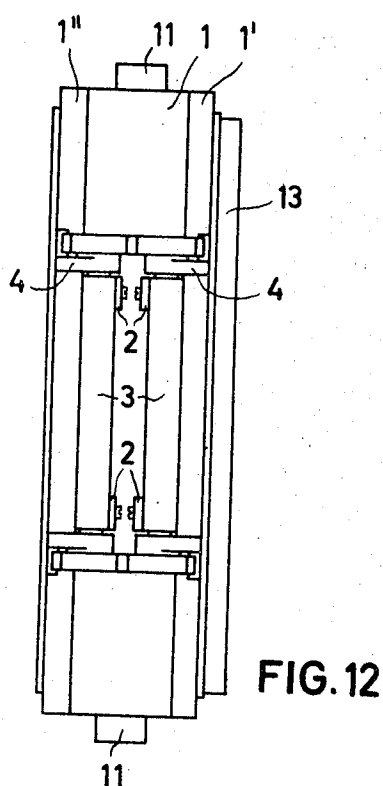
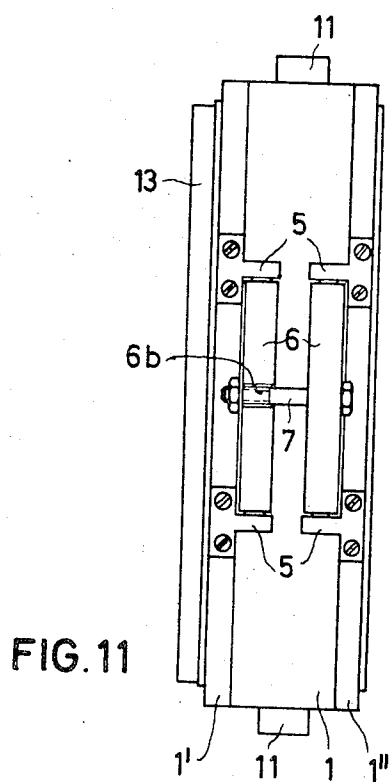
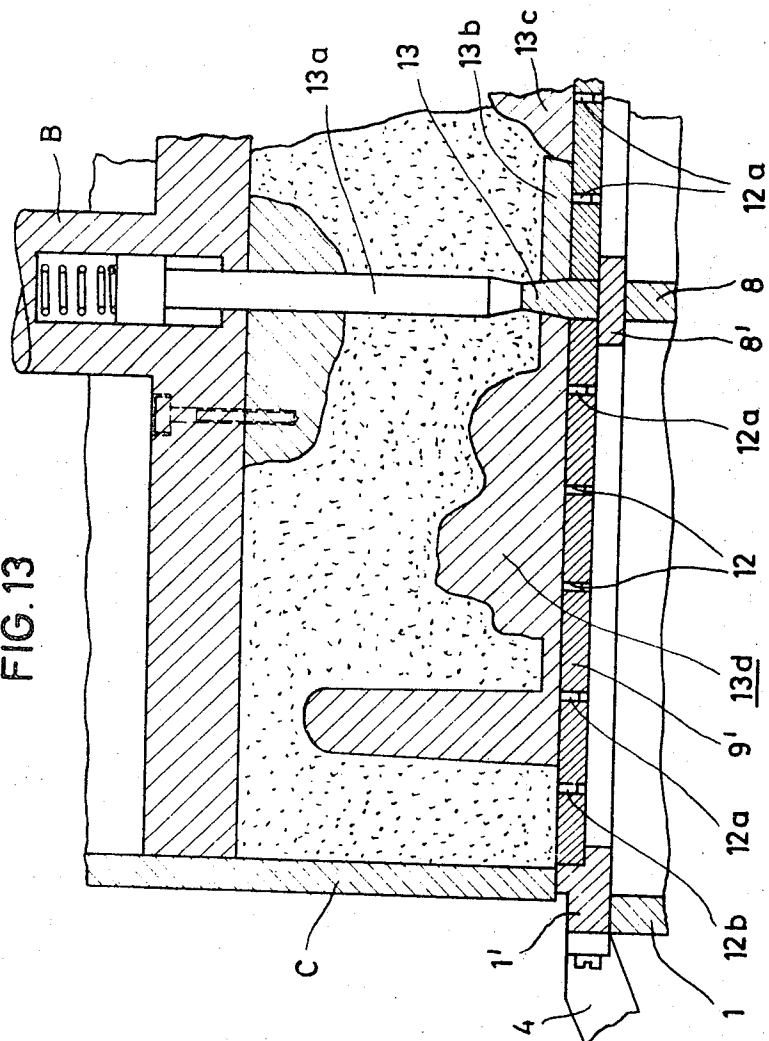


FIG. 13



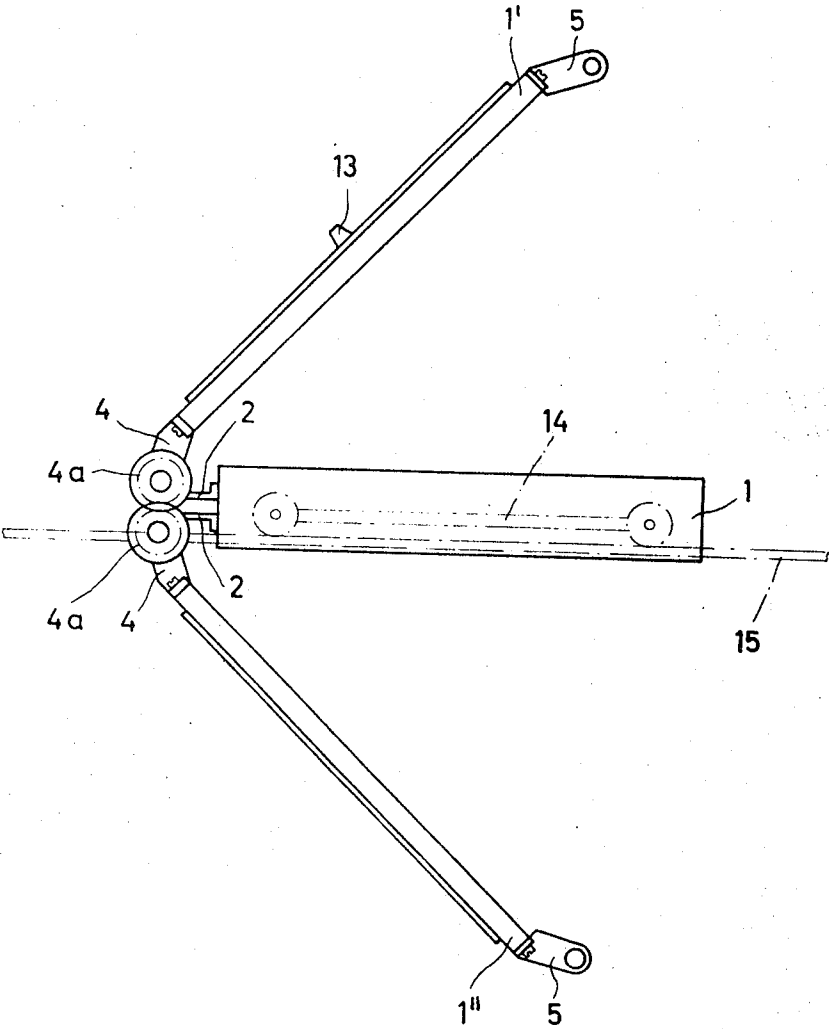
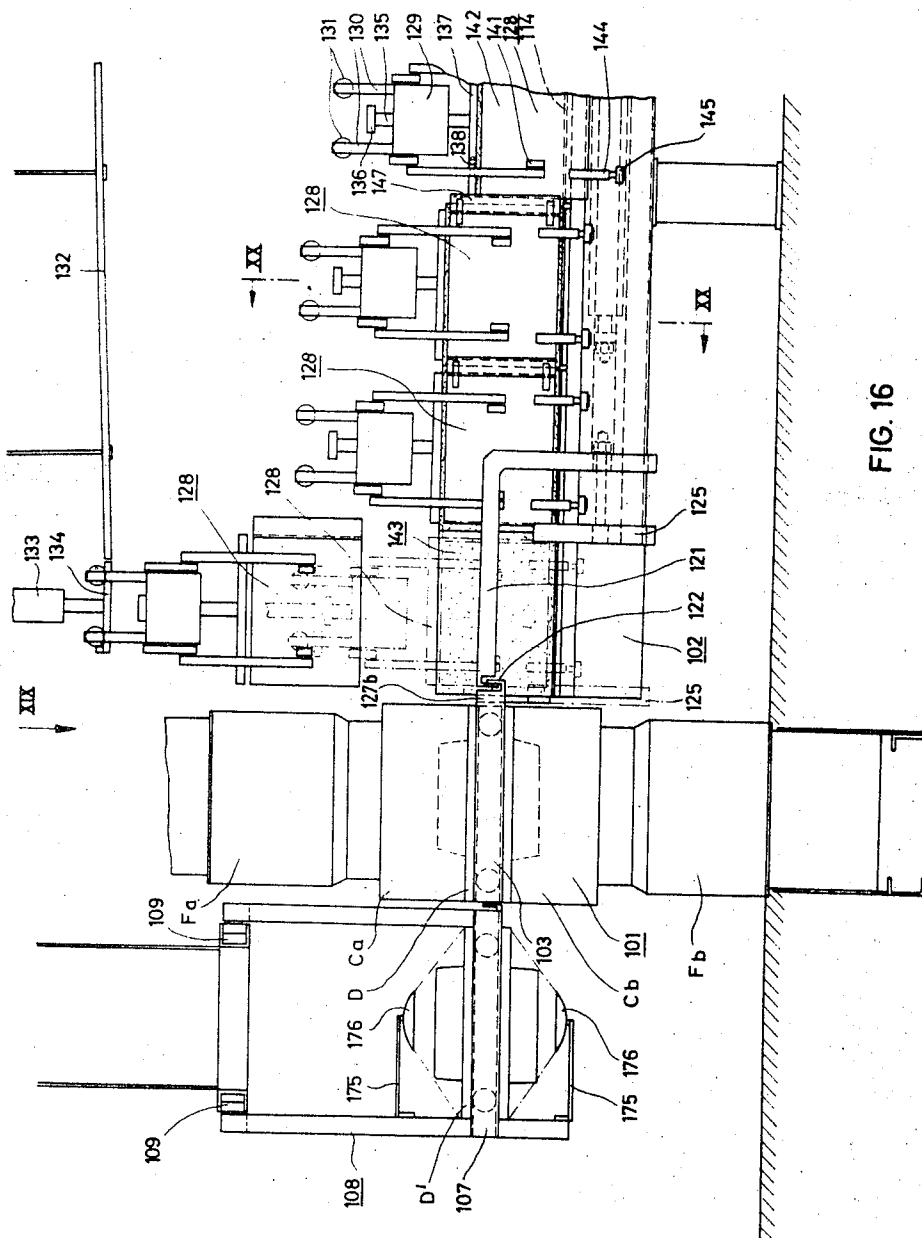
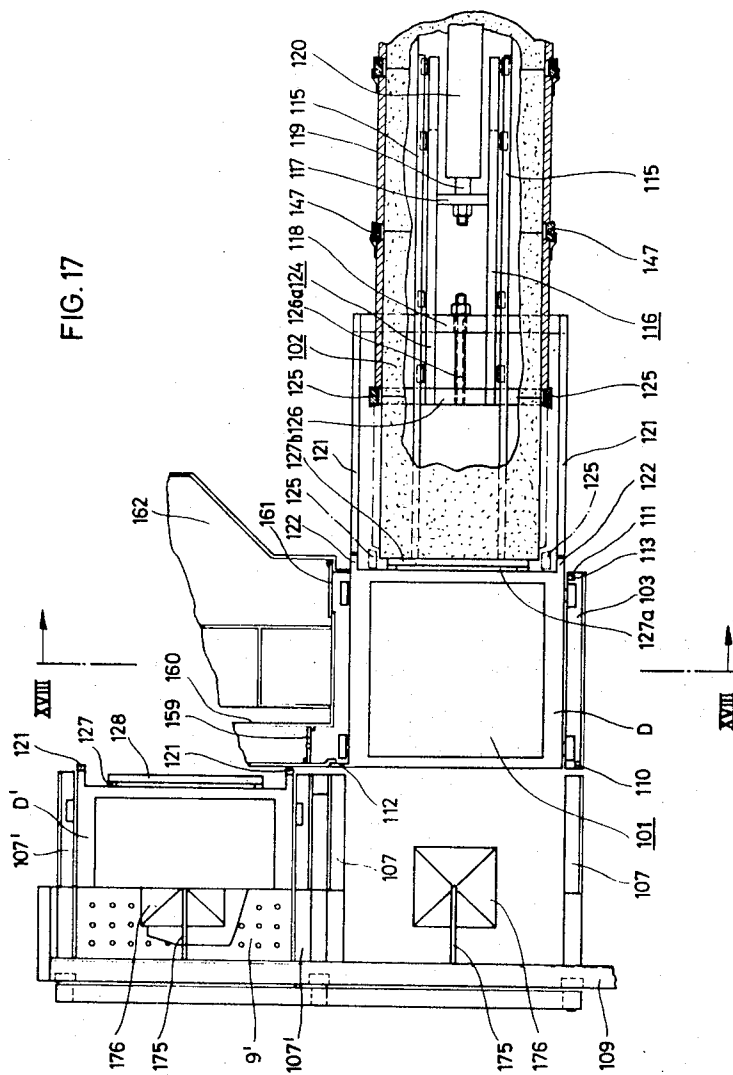


FIG. 14





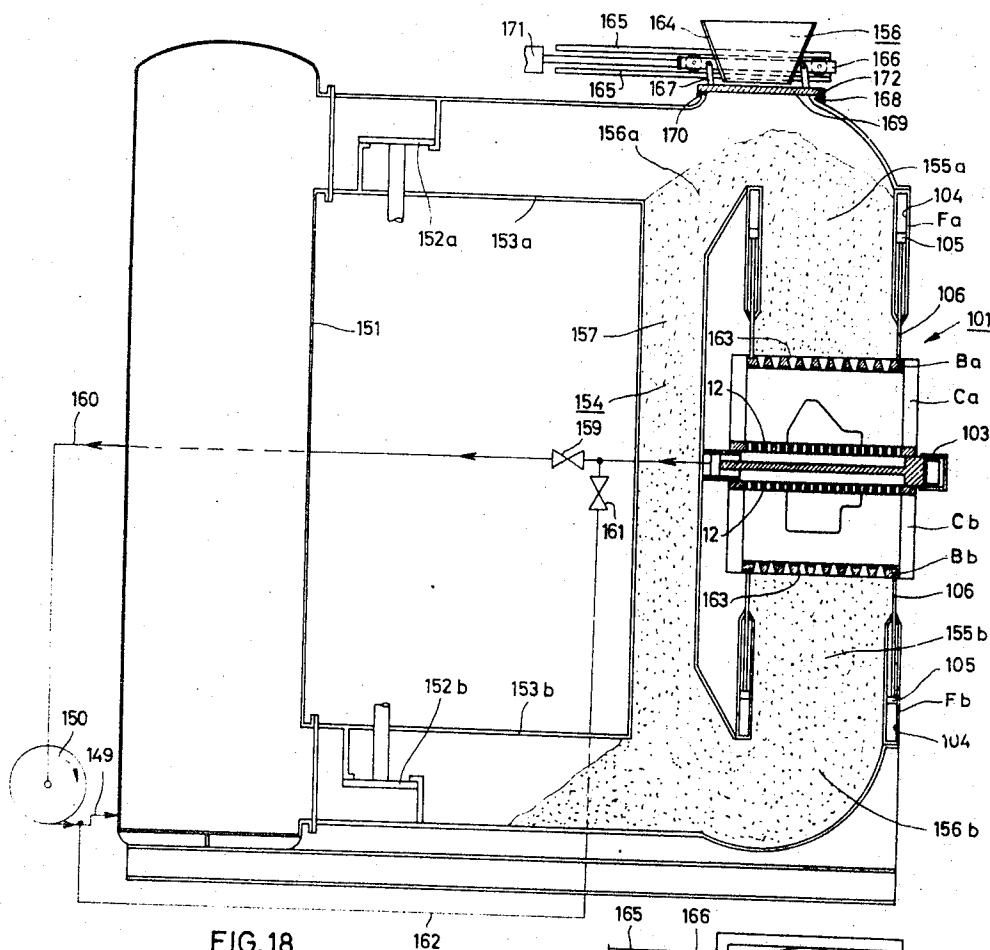


FIG. 18

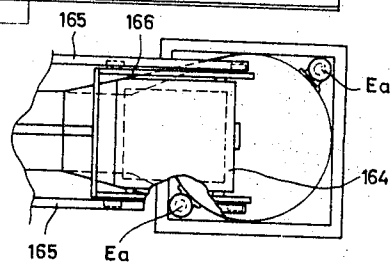
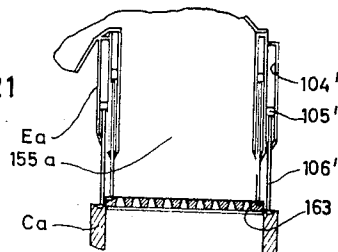


FIG. 19

FIG. 21



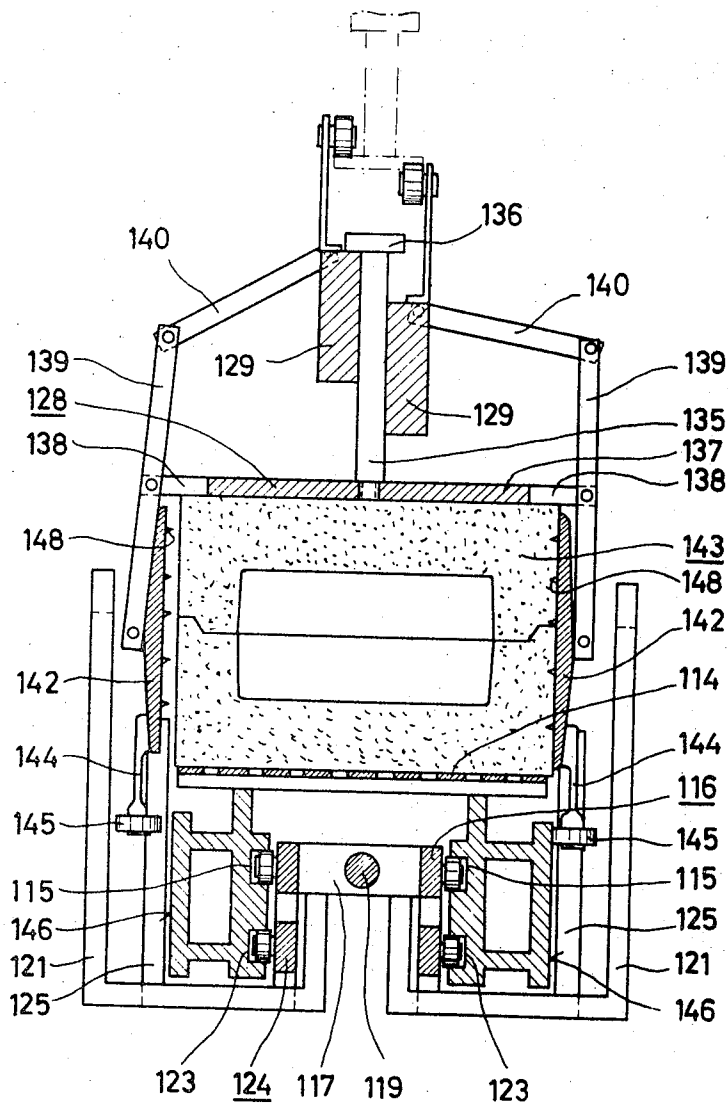


FIG. 20

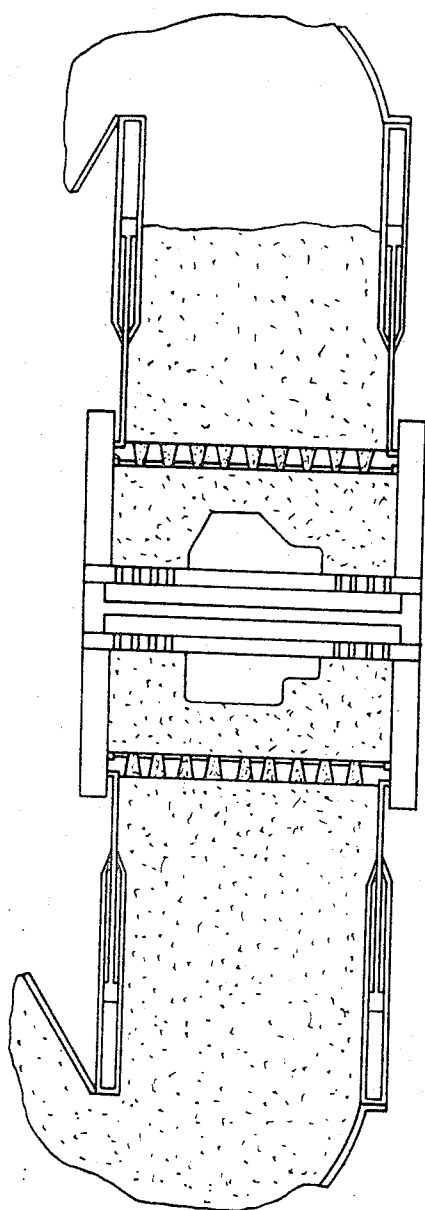


FIG. 22

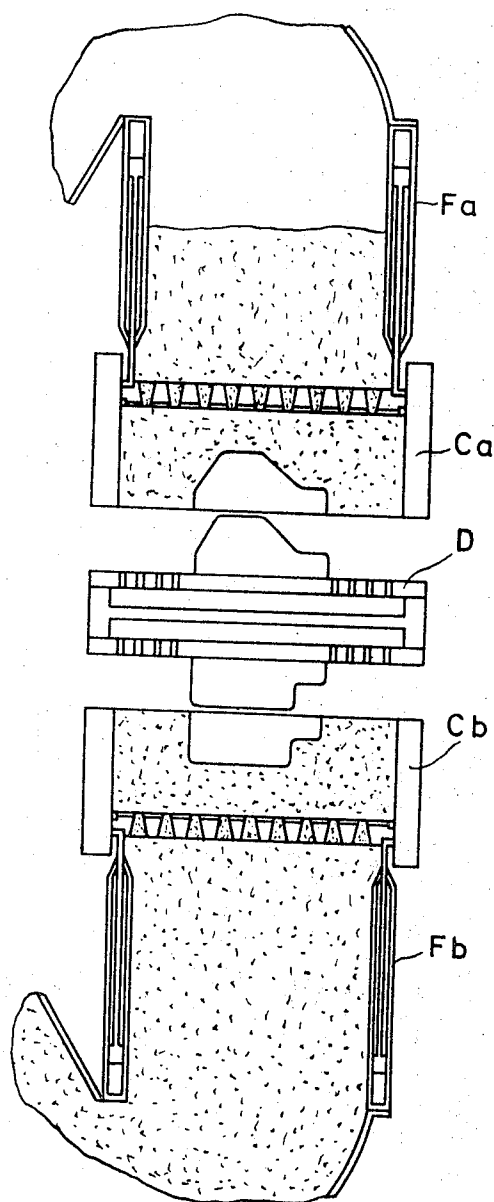


FIG. 23

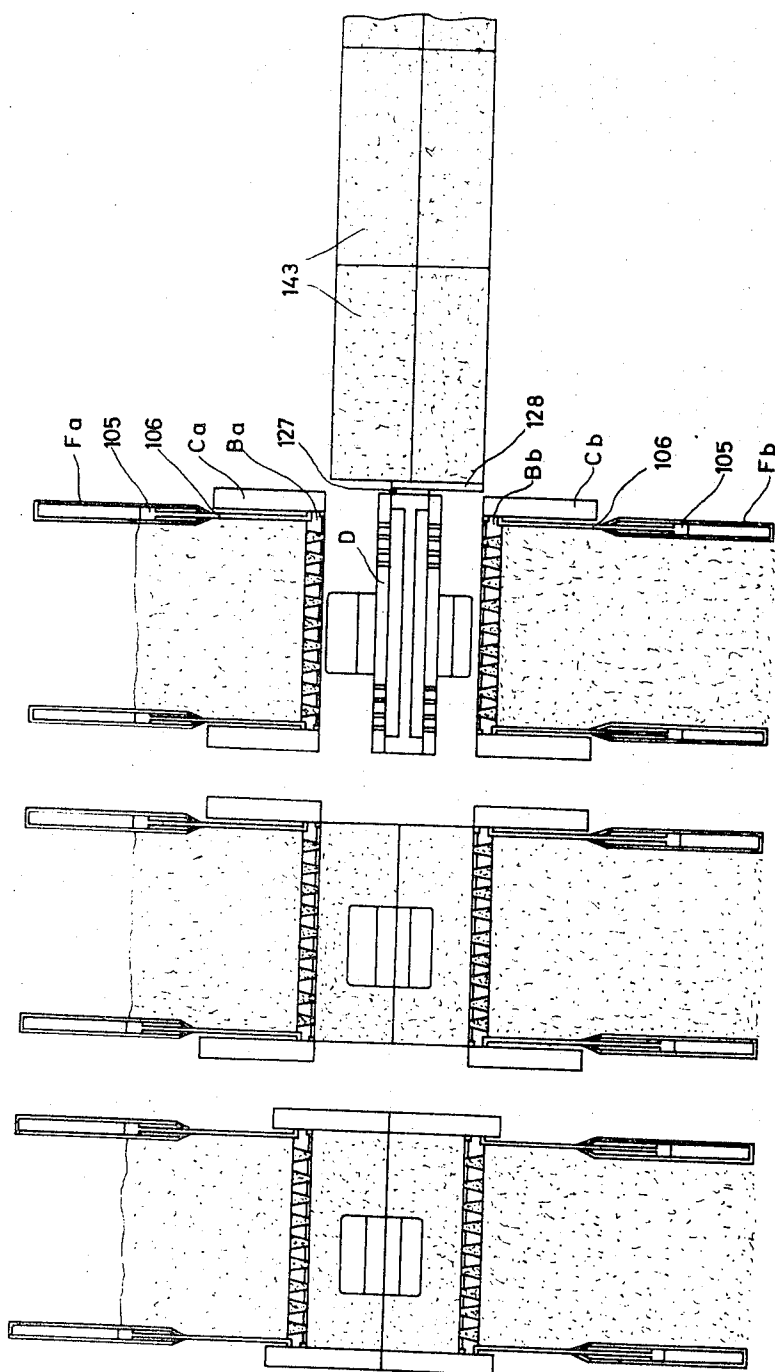
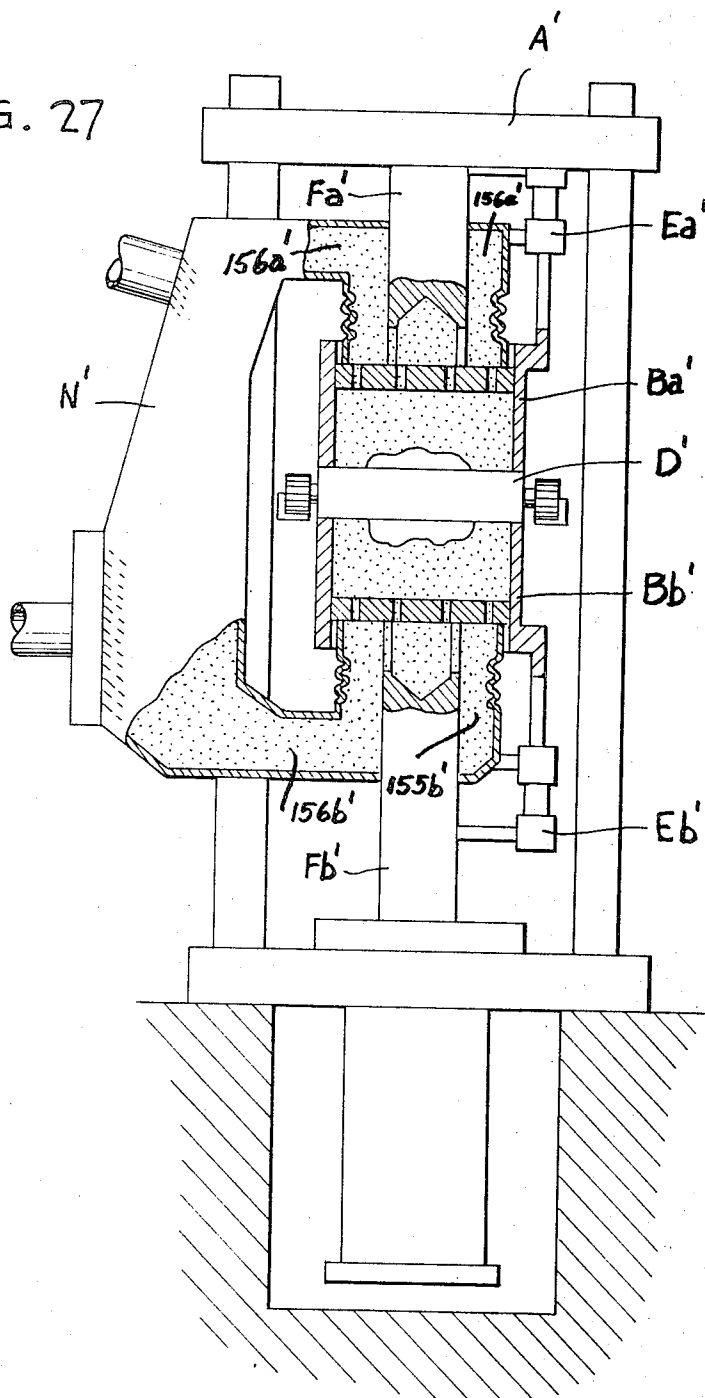


FIG. 26

FIG. 25

FIG. 24

FIG. 27



APPARATUS FOR AUTOMATIC PRODUCTION AND TRANSPORTATION OF FLASKLESS SAND MOULDS IN METAL CASTING

This application is a divisional application of copending application Ser. No. 753,640 filed Aug. 19, 1968, which will become U.S. Pat. No. 3,556,196 dated Jan. 19, 1971.

The invention relates to an apparatus for the automatic mechanical production as well as for the conveyance of horizontally divided flaskless sand molds.

In U.S. Pat. No. 1,021,938 is described a machine, operated rhythmically by a pressure medium, which has vertically moving mold frames defining together a frusto-pyramidal and vertically movable press dies, both arranged above and below a horizontal match plate that can be swung in a horizontal plane.

This known mold making machine permits the semi-automatic production of flaskless horizontally divided casting molds, but it has the disadvantage that the molding sand must be manually placed in the mold frames and that the finished mold can only be conveyed on base plates. The lifting of the finished molds from the mold making machine, and the transport of the latter to the casting pit must be effected by hand. The great amount of manual work involved in the known machine causes loss of time and high wage costs and precludes the efficiency of automatic procedures. Furthermore, the supply of a great number of base plates requires considerable investment costs. U.S. patent 3,229,366 describes a mold making machine of the above mentioned general type, but with a stationary upper mold frame, where the molding sand is pneumatically blasted through lateral slots in both mold frames into the interior thereof. Due to the known arrangement, the costly manual labor in charging the molding sand is avoided and the process is accelerated. However, this machine has the disadvantage that the molding sand blasted into the interior of the mold frames mixes with the compressed air conveying it and the pattern halves are damaged by the resulting erosive action of the sand blower, and also difficulties are encountered in eliminating the entrained air.

Both of the known machines have the same disadvantage insofar as the finished molds must be transferred from the mold making machine to the casting pit by hand, and they require base plates for that purpose. Furthermore, the finished molds must be covered with so-called "jackets" before they can be moved away, in order to withstand the pressure of the liquid metal during casting. The placing of the jackets over the finished molds must also be accomplished by hand. Needless to say, these jackets involve a considerable investment.

Swiss Pat. No. 364,078 and U.S. Pat. No. 3,008,199 disclose a plant for the production of vertically divided flaskless sand molds, often called, "stackmolds", because the opposing concave end-faces of the consecutive mold parts (forming a horizontally extending "stack") define the mold cavities. With these machines the molding sand is introduced by blasting through a lateral slot of a stationary horizontal mold frame defining a cavity between two vertical match plate halves. The molding sand is subsequently pressed by moving one of the match plate halves. Thereafter, the other match plate half is swung away from the finished mold body and the latter is pushed by horizontal movement of the first match plate half onto a horizontal conveyor

track where it joins as a newly added part a mold train stack moving toward a casting pit. This known machine has the advantage of being completely automatic, but because of the vertical division of the mold, there are difficulties regarding the insertion of the core and the production of larger castings, since the finished mold bodies cannot withstand high internal pressure. With this machine, the mold parts are laterally supported on both sides by stationary support bars. However, the friction between the support bars and the mold parts is so high that they contribute to damage of the mold parts rather than to reinforce them. Hence, the distance of transportation for the mold stack must be small between the molding machine and the casting pit.

U.S. Pat. No. 2,636,231 describes a machine for the automatic production of flaskless horizontally divided sand molds which has vertically moving mold frames defining together a frusto-pyramid and cooperating with horizontal match plate which can be swung horizontally from a rest position into a operative position. The upper mold frame has a perforated cover and the lower mold frame cooperates with a stationary perforated bottom plate. Horizontally movable sand chambers can be moved from loading positions underneath of respective sand hoppers into operating positions upward and below said mold frames. Air cylinders are arranged upward and below of such operating positions of such sand chambers and cooperate with the sand chambers so that when compressed air is introduced into said air cylinders, the molding sand is blasted through said perforations of said mold frames into the cavities of the latter. Despite its considerable complexity and bulkiness, this machine is only suitable for the production of small molds of little height. Furthermore, no provision is made for transportation of the finished molds.

German Pat. No. 871,499 discloses a machine for the automatic production of flaskless horizontally divided sand molds which have vertically movable closed mold frames defining a mold cavity with vertical side walls and cooperating with a match plate movable along horizontal guides between a rest position and an operative position and ejecting the finished molds when moving into the operative position. The mold sand is pneumatically blasted out of a retractable filling duct into the upper mold frame, after which the match plate with the mold frames is tilted around a horizontal axis and the sand is then blasted into the other mold frame. The tilting mechanism makes the machine complex and costly.

All of the above described known machines and plants have the disadvantage that the change of patterns is cumbersome and time-consuming, and the known arrangements are therefore uneconomical in the production of smaller series of castings or in the production of single castings.

The object of the present invention is, on the one hand, to achieve a fully automatic operation in the production of horizontally divided molds for small and larger castings thereby avoiding base plates and jackets, and on the other hand, to make such an automatic process economical by rapid pattern changes, not only for the production of large runs, but also for the production of small runs or single pieces as well as for small castings.

SUMMARY OF THE INVENTION

The invention relates to a flaskless sand mold producing and conveying plant having

- a. a sand mold making machine comprising substantially vertically movable upper and lower mold frames, upper and lower perforated dies respectively contained in said mold frames and capable of relative movement thereto, a match plate having patterns on the top and bottom surfaces thereof mounted for movement along horizontal guides from a rest position laterally adjacent said sand mold making machine to an operative position between said mold frames and dies, and an extendable sand chamber arranged respectively above the upper mold frame and below the lower mold frame, each of said sand chambers being connected to a sand tank laterally arranged to said upper and lower mold frames, a filling device for said sand tank, and a pressure gas tank connectable by, control valve means to each of said chambers;
- b. conveying means laterally adjacent said sand mold making machine opposite to the rest position of said match plate and being operatively connected with said match plate;
- c. and supporting means bearing against at least two sides of a finished mold and following the movements of that mold in cooperation with said conveyor means;

the plant operating such that said match plate is clamped by said upper and lower mold frames to form mold cavities, the mold sand is pneumatically filled into said cavities, said upper and lower dies compress that sand against said patterns to form a mold, said mold frames and dies are vertically moved from said match plate, said match plate is laterally moved to said rest position, the so-formed mold is closed and when said match plate is returned to said operative position the finished mold is ejected onto said conveying means and said supporting means are placed on said mold to go with it to a place near the knock-out place from where it returns to its starting place.

The match plate of the mold making machine of such a plant is preferably designed as a hollow body, the cavity of which is defined by a perforated top plate and a perforated bottom plate and by a match plate frame and is connectable selectively to a vacuum source or to a pressure source. The top and bottom plates are preferably pivotally mounted on said match plate frame. The patterns carried by such a match plate have preferably the form of integer pattern units which, in the case of the top surface, include an inlet, a feeder, an ingate and the respective pattern half. A test plate may be provided, having identical apertures and dimensions to said top and bottom plates of the match plate facilitate pattern changes and arrangements.

The mold making machine of the plant according to the present invention has preferably a cross-slide frame containing at least one extra match plate so that while said match plate is in said rest position it may be exchanged with said extra match plate.

The horizontal match plate guides of the mold making machine of the plant according to the present invention have preferably the form of gas tight ducts which are selectively connectable to a vacuum and pressure source and said ducts communicate with said match plate cavity to evacuate or pressurize the same.

The conveyor means of the plant according to the present invention are preferably driven conveyor means and may have the form of an endless steel belt. The arrangement may be such that said steel belt is driven when a pre-determined pressure is exerted by the last ejected mold.

A hydraulic drive may be mounted below said conveyor means which acts by way of forked intermediate members on said match plate and by way of sliding forks on the supporting means of the second last ejected mold. The forked intermediate members may be attached to the match plate by a hook which allows relative lateral movements as well as raising said match plate relative to said hook.

Infra-red heaters are preferably arranged above and below said rest position of the match plate to heat the same.

The supporting means of the plant according to the present invention may either have the form of endless belts arranged laterally adjacent said conveyor means or they may have the form of two horizontally pivoted clamping plates which support the lateral side of the finished mold. In the latter case, the supporting means are lowered onto the finished mold after it is ejected from the mold making machine, and the clamping plates have each at least one counter weight for the opening and closing thereof. In a preferred embodiment, said counter weight actuates said clamping plates by means of levers, said counter weight being connected to a trolley which in turn runs on a track between the knock-out station and a station adjacent said mold making machine where said supporting means is lowered over said ejected finished mold, as it is lowered said clamping plates are in a spread position exceeding the width of said mold, and a weight plate connected by said levers to said clamping plates and said counter weight above the top of said mold actuates the closing of said spread clamping plates against said mold.

In one embodiment of the plant according to the present invention, the dies of the mold making machine are actuated by a hydraulic piston and cylinder, and the piston rod connecting said die to each respective piston pass through said respective upper and lower chambers.

According to another embodiment of the plant of the present invention, said upper and lower sand chambers are respectively defined by annular pistons and cylinders having a cylindrical connecting tube actuating each respective die. The upper and lower mold frames of the mold making machine may be hydraulically actuated by pistons and cylinders mounted laterally said annular pistons and cylinders or they may be respectively hydraulically operated by concentric pistons and cylinders.

According to a preferred embodiment of the invention there may be two gas pressure lines and valves between said pressure gas tank and said upper and lower sand chambers, and the sand chambers and the mold sand tank may form a C in vertical cross-section, with said gas pressure line entering respectively at the upper and lower portions of the C.

The filling device of the plant according to the present invention preferably consists of a hopper opening into the top of the sand tank, and a hydraulically operated horizontal slide valve may be provided consisting of a carriage movable in a horizontal guide and a hori-

zontal cover plate fitting to the carriage by toggle levers may be provided to close the hopper entrance.

Other features and advantages of the invention will become apparent from the following specification of some embodiments with reference to the attached drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a partial section of a schematic elevation of one embodiment of the mold making machine for sand mold production and conveyor plant according to the invention;

FIG. 2 to 6 show a simplified schematic lateral elevation, similar to FIG. 1, which represents the machine corresponding to its operation successively in pressing position, in lifting position, in core-inserting position, in mold-closing position and in mold ejecting position;

FIG. 7 shows a schematic elevation of the mold making machine as well as of the respective conveyor track for the finished mold train of the mold-production and conveyor plant during the ejection of a finished mold, turned by 90° about the vertical axis of the machine as compared to FIGS. 1 to 6;

FIG. 8 shows a schematic cross-section through the conveyor track for the mold train of the plant according to the invention with the supporting means according to the invention for supporting the side walls of the finished molds;

FIG. 9 shows a partial section of a schematic top view of a match plate, preferably to be used in combination with the plant according to the invention, a so-called "top plate" being inserted in the left half of the drawing;

FIG. 10 represents a section along the plane X—X in FIG. 9, seen in the direction of the arrows, which shows that in addition a so-called "bottom plate" is inserted in the left half of the match plate according to the invention;

FIG. 11 shows a side view in the direction of arrow XI in FIG. 9;

FIG. 12 shows a side view in the direction of arrow XII in FIG. 9;

FIG. 13 shows an enlarged schematic partial section along the plane X—X in FIG. 9, which represents the match plate illustrated in FIGS. 9 to 12 with the attached inlet, pattern, and a pattern unit according to the invention in the production of a mold half;

FIG. 14 shows a schematic side view in the direction of the arrow XIV in FIG. 9, in which the top and bottom part of the match plate is shown in a partly folded state;

FIG. 15 shows a schematic perspective view of a preferred embodiment of the match plate according to the invention used in combination with a mold making machine according to the invention.

FIG. 16 shows a schematic partial side view of another embodiment of the sand mold production and conveyor plant according to the invention;

FIG. 17 shows a partial section of a top view of the plant represented in FIG. 16;

FIG. 18 shows a partial section along the plane XVIII—XVIII in FIG. 17;

FIG. 19 shows a partial top view of the plant represented in FIG. 16 seen in the direction of the arrow XIX in FIG. 16;

FIG. 20 shows a schematic section along the plane XX—XX in FIG. 16, seen in the direction of the arrows;

FIG. 21 shows a schematic partial vertical-longitudinal section through a modified embodiment of the mold frame and press die arrangement of a mold making machine according to the invention;

FIGS. 22 to 26 show respectively partial vertical-longitudinal sections through the mold making machine of the sand mold production and conveyor plant represented in FIGS. 16 to 20 in various operating positions,

and FIG. 27 is a view similar to FIG. 1 of another embodiment of the invention.

FIRST EMBODIMENT

With reference to FIGS. 1 to 8 of the drawings we will now describe an embodiment of a sand mold production and conveyor plant according to the invention will now be described.

FIG. 1 shows a part of the mold making and conveyor plant according to the invention showing the foundation frame of the mold-making machine according to the invention with cross yoke A. In this foundation frame is held for vertical displacement a top die Ba, which is fixed, for example, in this embodiment of the invention during the working cycle of the machine. This top die can be set at different levels for the production of patterns of different profile height by means of a hydraulic drive Fa, so that the working strokes of the machine and their time intervals are kept as short as possible. An upper mold frame Ca is vertically displaceable with respect to top die Ba by means of a hydraulic drive Ea. A double-sided match plate D is at the beginning of the working cycle of the machine in the position represented in FIG. 1 of the drawings, in which the molding sand is introduced pneumatically into the machine. A bottom die Bb of the machine can be moved vertically up and down in known manner by means of a hydraulic drive Fb. A lower mold frame Cb is vertically displaceable relative to this bottom die Bb by means of a hydraulic drive Eb.

FIG. 7 of the drawings shows an ejection device G for a match plate D of the machine in a schematic representation. This device serves also to insert the match plate again into the machine and thus pushes the finished mold at the same time onto a conveyor belt 1 of the plant according to the invention. The match plate D is either designed itself as a truck and is provided to this end with wheels, or it rests on a horizontally moving frame-shaped truck, whose inside width is greater than the bottom mold frame Cb. According to this embodiment of the machine the bottom mold frame together with the bottom die Bb can pass during the pressing operation through the frame-shaped truck lifting the match plate D upwards and pressing it against the top die Ba.

FIGS. 7 and 8 of the drawings also show the conveyor belt 1 of the mold-making plant according to the invention forming the conveyor track of the mold train, on which ejected finished molds are arranged. The edges of the horizontal separating joints of these flaskless sand molds have, according to the invention, complementary bevels L, which serve to fix the upper and lower mold halves during the feeding processes. They have been omitted for clarity's sake in FIGS. 1 to 7, in the match plate.

FIG. 8 shows a schematic cross-section through the conveyor belt 1 and also supporting means according to the invention for the lateral support of the finished

molds resting on the conveyor belt. These have, for example, the form of clamping plates M, as mentioned above, which are pressed by means of a controllable linkage, according to the invention, laterally against the finished molds so that the latter can withstand the casting pressure deformation force resulting from the feeding process. These clamping plates M can also be actuated, if this seems advisable, from the top, for example by using known weight irons as it is shown on the right of FIG. 8.

FIG. 1 of the drawings also shows the pneumatic filling device N for the molding sand of the mold-making plant according to the invention. The molding sand is accelerated during the filling process simultaneously with air from the top and from the side. In this way a uniform filling of both mold frames Ca and Cb is achieved. Louvered diaphragms O ensure the proper air flow.

FIRST EMBODIMENT OPERATION

The individual working cycles of the mold-making plant according to the invention will now be described on the basis of FIGS. 1 to 7 of the drawings.

FIG. 1 shows the first working stage. Here the upper mold frame Ca and the lower mold frame Cb are applied to the interposed match plate D. In this state the molding sand is introduced pneumatically by means of the device N. This is the basic first step for the pressing process.

FIG. 2 shows the position of the mold frames Ca and Cb after the pressing. In the compression of the molding sand, the bottom die Bb has moved upward relative to the lower mold frame Cb, which is held somewhat by a certain initial stress of the hydraulic drives Ea, Eb and has thus been protected from uncontrolled sliding down, for example, by its own weight. The bottom die Bb has lifted the match plate D from its rails and taken it upwards together with the upper mold frame Ca relative to the top die Ba, so that the molding sand contained in the upper mold frame has also been compressed. A slight backpressure can be exerted by means of the upper hydraulic drive Ea.

FIG. 3 of the drawing shows the detached position in which the two mold frames Ca and Cb are pulled apart by lowering the bottom die Bb and lower mold frame Cb without any relative movements with respect to the dies and mold frames. The match plate D is again placed on its frame-shaped truck or, if it is designed itself as a truck, on the rails and is subsequently moved to the rear by means of the horizontally acting hydraulic drive indicated at G in FIG. 7 of the drawings. In case the match plate D is designed itself as a truck, a hook-shaped vertically detachable connection is provided between this hydraulic drive and the match plate D, likewise indicated in FIG. 7 (not numbered).

The removal of the match plate D results in the core-inserting position represented in FIG. 4. Cores can be inserted either by hand or by means of a special core-inserting mechanism. Subsequently the bottom die Bb with the lower mold frame Cb and the lower mold half moves up until it bears on the upper mold half, the two mold frames Ca and Cb being simultaneously pulled back or subsequently pulled back by means of the hydraulic drives Ea and Eb so that they release the entire mold.

The mold is thus closed and rests in the position shown in FIG. 5 on the bottom die Bb. In its following

downward movement it is disengaged from the top die.

The bottom die subsequently moves so that it is aligned with the conveyor belt I. This position is the ejection position represented in FIG. 6.

If the match plate D and its frame-shaped truck are introduced again by means of a hydraulic drive G, the finished mold K is ejected at the same time onto the conveyor belt I as shown in FIG. 7.

The two mold frames Ca and Cb are subsequently raised and lowered again by means of their hydraulic drives Ea and Eb until they bear again on the match plate D, the starting position according to FIG. 1 has been reached again and the working cycle can start anew.

The finished molds form, as shown in FIG. 7, a closed mold train having two abutting surfaces each of the four lateral surfaces of the finished molds supporting one another. The contact pressure of the molds, which is equal to the ejection power and the driving force required for a non-driven conveyor belt must be limited so that overstress of the molds which might result in lateral destruction is avoided. To this end, the conveyor belt I can be driven or supplemented, for example by means of a stepping mechanism, whose activity is preferably started by overpressure of the pressure medium actuating the hydraulic drive G.

The arrangement can be such that a synchronous motion impulse, slightly trailing behind the inserting movement of the match plate, is imparted to the conveyor belt, with the power of the inserting movement of the match plate being so limited that destruction of the finished molds is avoided. The driving power of the conveyor belt is preferably obtained from a power source producing power in excess of the introduction of the match plate.

The support of the exposed other two sides of the molds is effected, as mentioned above, by clamping plates. These run in synchronism with the conveyor belt I. They can be secured by a linkage on the belt or they can be articulated on weight irons guided at the top, or they can be secured on a separate belt, which can follow, for example, by friction contact.

The control of the working cycle of the mold making plant according to the invention can be effected in a simple manner, for example, by limit switches over control pistons by means of a pressure medium. The thrusts of the various hydraulic drives, for example of the hydraulic drives Ba, Bb, Fa, Fb and G, can be limited by known means, for example, overflow valves.

The height and area of the molds can be increased by corresponding dimensioning of the parts of the plant, for example, of the mold frames, press-dies, conveyor belt etc. up to orders of magnitude which were possible so far only in automatic plants with mold flasks.

The double-sided support of the finished molds advancing on the conveyor belt I can be effected in a modification of the invention, instead of by the above described clamping plates, by conveyor belts arranged at both sides of the finished mold train and extending parallel to the conveyor belt I, whose bank surfaces are vertical. Such supporting conveyor belts can be either driven or non-driven. They can be covered, if necessary, with spur plates extending perpendicularly to the conveyor belt surfaces, which reach between the individual finished molds and support their end faces.

Both the conveyor belt I and the above mentioned supporting conveyor belts can be supported to such an

extent by closely arranged guide rollers that they lay practically in a plane surface. They can have, for example, the form of endless steel belts.

The clamping plates used according to the invention preferably for supporting the finished mold train on both sides can be made tiltable about axes parallel to the direction of conveyance in the embodiment of the invention described here, and their respective degrees of tilting or pressing against the outer walls of the finishing mold train can be controlled, for example, by a cam track extending parallel to the conveyor belt.

Instead of a single conveyor belt I, several conveyor belts can also be used which can be displaced transverse to the direction of conveyance and which can cooperate selectively with the mold making machine according to the invention.

The device according to the invention for the pneumatic feeding of the molding sand into the two mold frame cavities has preferably the form of a rotatably or fixedly mounted box or drum-shaped tank in which are arranged louvered air baffles, and in which the molding sand is accelerated by compressed air introduced simultaneously both from the top and from the side.

As it can be seen from FIGS. 1 to 6 of the drawings, the hydraulic drives effecting the vertical displacement of the two mold frames are arranged parallel to the hydraulic drives effecting the vertical displacement of the two press dies. As it will be described below, a concentric arrangement of the hydraulic drives for the press dies and the mold frames can also be provided instead of the parallel arrangement.

MATCH PLATE

The match plate 4 and the truck carrying the match plate in the ejection position of the machine can have on the side facing the conveyor belt I, a sliding die, for example, in the form of an easily moving articulated vertical surface, which bears during the ejection of the finished mold on the vertical outer mold surface facing it.

With reference to FIGS. 9 to 15 of the drawings, the details of a match plate according to the invention will now be described, which can be used in combination with the above described sand mold production and conveyor plants according to the invention represented in FIGS. 1 to 8, and also with other embodiments of such a plant, as will be described more fully below.

The preferred embodiment of a match plate according to the invention, represented schematically in FIGS. 9 to 14, has a plate frame which consists of a main frame part 1 and two upper and lower frame parts 1' and 1'' respectively articulated thereon. The top and bottom edges of the main frame part 1 of the match plate and the respective surfaces of the upper match plate frame part 1' and of the lower main frame part 1'' bearing thereon are so ground that the tight mutual bearing of these match plate frame parts shown in FIGS. 10, 11 and 12 of the drawings is ensured. On one side of the main frame part 1 of the match plate frame are secured, for example, four slightly elastic holding angles 2 which are pushed toward each other by their slight spring effect in the direction of the arrows P indicated in FIG. 10. At the free ends of these holding angles 2 are secured axle pieces 3 whose salient free ends, on both sides, are designed as axle journals 3a. On one side each of the top and bottom part 1' and 1'' respectively of the match plate frame are secured, for exam-

ple, two rigid hinge arms 4 which form an integral part with meshing gear wheels 4a in whose hub bores are supported the axle journals 3a of the axle pieces 3. The dimensions of the parts are such that, when the top part 1' of the match plate frame and the bottom part 1'' of the match plate frame are turned so that they bear on the two ground surfaces of the main part 1 of the match plate frame, the holding angles 2 on both sides are elastically bent against the directions indicated by the arrows P, so that they tend to press the top part 1' and the bottom part 1'' of the match plate frame against the respective bearing surfaces of the main part 1 of the match plate frame. On the other hand, the elastic holding angles 2 have a tendency, when top part 1' and bottom part 1'' of the match plate frame are folded away from the main part 1 of the match plate frame, to press the loosely meshing gear wheels 4a into a tight mutual engagement to make sure that the movements of the top part 1' and of the bottom part 1'' of the match plate frame are specially synchronized to ensure a complete weight balance in favor of a low energy expenditure for moving these parts. On the sides opposite the sides of the top plate 1' and of the bottom plate 1'' of the match plate frame holding the respective hinge arms 4 are likewise secured limited elastic clamping parts 5 whose free ends are provided with bearing bores 5a in which are supported journal-shaped free ends 6a of clamping pieces 6, which in turn can be pressed together by means of a clamping screw 7. This clamping screw 7 passes, on the one hand, through a continuous bore of one clamping piece 6, and on the other hand, is arranged in a slot-shaped recess 6b of the other clamping piece so that it can be moved away to disengage the clamping connection. By tightening the clamping screw 7, a tight mutual bearing of the associated bearing surfaces of the main part 1 of the match plate frame, on the one hand, and of the top and bottom plate 1' and 1'' respectively of the match plate frame, on the other hand, can be achieved.

The match plate is divided in the embodiment represented and described here by a central holding bar 8, 8' and 8'' respectively into two halves so that the top and bottom side of the match plate according to the invention receiving the pattern change are each divided into two parts. Such a subdivision is naturally not compulsory and can be omitted by eliminating the holding bars 8, 8', 8''. On the other hand, a further subdivision of the top and bottom sides of the match plate according to the invention by additional holding bars, not shown, in longitudinal and transverse directions is also possible within the framework of the invention. The holding bars 8, 8', 8'' are preferably detachably mounted on the frame parts 1, 1' and 1'' of the match plate according to the invention in a manner not shown in the drawing. The top and bottom plates 1' and 1'' respectively of the match guide frame and the top and bottom parts 8' and 8'' respectively of the holding bars are provided with corresponding shoulders or ledge-shaped projections on which rest a so-called "top plate" 9' and a so-called "bottom plate" 9'', which are connected by detachable fastening means, not shown in the drawings, with the top part 1' and the bottom part 1'' respectively of the match plate frame. The top plate 9' and bottom plate 9'' respectively are the carriers of the change pattern halves which are indicated in FIGS. 9 and 10 of the drawings by broken lines.

On the inside of the main part 1 of the match plate frame as well as on the holding bars 8, if any, can be provided shoulders and holding strips 1a respectively and 8a, which serve as a support for inner reinforcing plates 10, which, just like the holding bars 8, serve to increase the resistance of the match plate according to the invention against external pressure. The shoulder and holding strips 1a and 8a also have the function, for reasons to be discussed later, of serving as a packing support for relief plates, if relief patterns must be molded with the match plate according to the invention.

On one or several of the outer four sides of the main part 1 of the match plate frame according to the invention are preferably secured jarring devices 11 which have been partly omitted in the drawings for clarity's sake.

The top plate 9' and the bottom plate 9'' are provided according to the invention with apertures 12 arranged preferably in raster form, which serve primarily to secure the change pattern halves. These fastening apertures 12 preferably have the form of cylindrical bores and are preferably oriented toward each other in the form of a square raster, as can be seen from FIG. 9. The change pattern halves to be secured on the top plate 9 and on the bottom plate 9'' are preferably provided in known manner with cylindrical fitting pins 12 (FIG. 13) which can be introduced into the fastening apertures 12. The fastening of the change pattern halves on the top plate 9' and bottom plate 9'' can be effected with screws, threaded bolts, clamping bolts, clamp clips or by magnetic force, in which latter case the top plate 9' and the bottom plate 9'' must be made of corresponding magnetic material. Apart from the possible magnetic fastening of the change pattern halves, however, the top plate 9' and the bottom plate 9'' can also be made of a different material, for example, of wood or of plastic.

The fastening apertures 12 can be numbered continuously, as it can be seen from FIG. 9. According to the invention, an additional trial plate can be provided in this case, which is not represented in the drawings, whose top and bottom surfaces, likewise provided with numbered apertures, are identical in their dimensions, size, arrangement and numbering of these apertures with the top and bottom surfaces of the match plate according to the invention and which can be inscribed with wipe-off writing materials. This measure according to the invention permits experimenting during the operation of the mold-making machine by means of the trial plate the respective optimum covering of the pattern plate with the respective patterns to be molded in the new series, and permits the marking of the fastening apertures necessary for fixing and fastening the pattern halves on the pattern plate. The fastening of the pattern halves on the match plate according to the invention can then be effected in a very short time by using the marked numbers of the necessary fastening apertures. The inscribability of the top and bottom surfaces of the trial plate according to the invention with wipe-off writing materials makes it possible to outline the change pattern half applied on the trial plate, for example, with a crayon, and thus to determine in a short time which fastening apertures are necessary for fastening and fixing the pattern halves on the match plate according to the invention.

The fastening apertures 12 of the pattern plate according to the invention have another function, too, however. As can be seen from the drawings and from the description, the match plate according to the invention forms a hollow body whose interior is in communication with the outside atmosphere only through the fastening apertures. According to the invention it is therefore provided that the match plate according to the invention can be connected over controllable switching means to a vacuum and/or compressed air-source. Such an evacuation possibility of the interior of the match plate according to the invention facilities, the feeding of the molding sand by means of compressed air into the mold frame and thus leads not only to a marked acceleration of the feeding process, but also helps substantially to reduce or eliminate completely the difficulties encountered normally in these cases when molding complicated patterns. It is readily understandable that during the evacuation of the interior of the match plate according to the invention the elimination of the compressed air necessary for filling the molding sand into the mold frame is effected through the uncovered fastening apertures 12 of the top plate 9' and bottom plate 9'', and that it is also possible to reduce the pressure of the compressed air necessary for filling in the molding sand. On the other hand, due to the possibility of putting the hollow of the pattern plate according to the invention under overpressure, the detachment of the finished mold from the pattern is greatly facilitated, since the compressed air issuing from the interior of the match plate through the apertures 12 not covered by the pattern provides an air cushion below and above the two mold halves to be removed which facilitates their detachment and removal.

In order to be able to limit the passage of air through the fastening apertures 12 of the top plate 9' and of the bottom plate 9'' during the filling of the molding sand during the detachment of the finished mold halves, it is possible according to the invention to insert known nozzle plugs 12b (FIG. 13) into the fastening apertures 12 not required for fastening and fixing the change-pattern halves which permits only a limited passage of air through these apertures. These nozzle plugs are preferably designed as slotted plugs whose slot width is selected so narrow that the entrance of molding sand particles into the hollow of the match plate during the evacuation of this hollow is avoided.

The detachability of the top plate 9' and of the bottom plate 9'' from the main part of the match plate is of particular importance, with a great subdivision of the match plate cover surfaces by holding bars 8' and 8'', when the match plate is to be covered simultaneously with different series of different patterns or different quantities. In these cases the time necessary for the pattern change by removing the respective top and bottom plate 9' and 9'' and attaching another top and bottom plate already covered with the new pattern halves is substantially reduced. The fastening apertures 12 can be provided readily directly in the upper and lower bottom of a solid or hollow match plate as continuous holes. This has the result that the division of the match plate frame of the match plate according to the invention into a main part 1 and a top frame 1', as well as a bottom frame part 1'', is likewise not compulsory. This division, and particularly the simultaneous possibility of tilting away from the top part 1' and the bottom part 1'' of the match plate frame serve again merely to ac-

celerate the change of the patterns and particularly to make the hollow of the match plate according to the invention accessible, which is of particular advantage when relief plates are to be molded. FIG. 14 of the drawings shows the advantage of a weight-balance resulting from the symmetry of the folding away of the top plate 1' and of the bottom plate 1'' of the match plate frame according to the invention.

If the evacuation or pressurization of the hollow of the match plate according to the invention is considered and the match plate frame is divided into a main frame part 1 and into a detachable and fold-away top frame part 1' and an identical bottom frame part 1'', it may be advisable to provide on or in the proximity of the mutual contact edges of these parts packing strips of suitable material, for example, of rubber.

FIGS. 9 to 14 of the drawings shows that a so-called "runner" 13 is preferably detachably mounted on the top side of the top part 1' of the match plate frame. As it can be seen, particularly from FIG. 13, the runner 13 cooperates with a sprue 13a arranged for elastic displacement on the top die as well as, if necessary, with one or more correspondingly arranged risers, which are likewise arranged in suitable manner on the top die of the respective mold-making machine. Naturally several runners can be provided at a suitable point instead of a single runner 13. FIG. 13 shows on the right side next to runner 13, a gate 13b attached on the top plate 9' by means of a fitting pin 12a, which is joined by a pattern 13c, likewise fixed with fitting pins 12a on the top plate. The invention also concerns the idea of using in connection with such a runner 13 or with several such runners one-piece pattern units 13d, which can likewise be seen in FIG. 13. These units consists, in the case of the top side of the match plate, of a gate, if necessary a feeder with inlet and the respective pattern half, the gate adjoining directly the respective runner 13. Due to such a measure according to the invention, the time necessary for changing the patterns is likewise reduced to a minimum.

These pattern units 13d are made of cast iron, brass, aluminum, wood or plastic, and are one piece or composed of several parts by means of a common holding strip. The units can consist of magnetic material, or can have a magnetic or magnetizable holding shoe, if they are to be secured by magnetic force on to the match plate.

MATCH PLATE IN USE

In connection with FIGS. 14 and 15 of the drawings, the application of the match plate according to the invention in combination with the mold-making machine according to the invention as illustrated in FIGS. 1 to 8 will be described. As indicated in FIG. 14 the match plate 1 according to the invention rests on a slide frame 14 (broken lines) which can be displaced along horizontal guide rails 15. In FIG. 15 of the drawings the range of action of the mold frame and of the press dies of the respective flaskless mold-making machine is indicated by an upper and lower mold frame 16' and 16'' as represented by broken lines. As it can be seen from FIG. 15, two match plates 1A and 1B are arranged side by side in the slide frame 14. FIG. 15 shows furthermore that the slide frame 14 can be moved back and forth in the direction of arrow Q by means of a hydraulic drive (not shown in the drawing) between a position in which the match plate 1A is in the range of action

of the mold frame 16' and 16'' of the mold-making machine, and the represented position in which the match plate 1A is outside this range of action. According to the invention, the guide rails 15, which are likewise represented in FIG. 15, forms a part of another slide frame 17, which can be moved back and forth by means of a hydraulic drive, secured on the machine, along guide rails 19 transverse to the direction of arrow Q in the direction of the arrow R in such a way that, on the one hand, the match plate 1A can be brought in the represented position of the slide frame 17 into the range of action of the mold frames 16' and 16'' of the mold-making machine, and on the other hand, in an unrepresented position of the slide frame 17, the match plate 1B can be brought into this range of action. Both slide frames 14 and 17 are so designed that the mold-making machine can cooperate unhindered with the respective match plate when the match plate 1A or 1B is in the above-mentioned operative position.

The last described double match plate arrangement according to the invention permits the pattern to be changed during the operation of the mold-making machine on the respective match plate which is not in operative position, while the other match plate moves in and out of the range of action in the working rhythm of the mold-making machine. Shut-down time for the change of the patterns is thus avoided.

In the arrangement described in connection with FIG. 15 of the drawings, it may be of advantage to arrange three or more match plates side by side on the slide frame 14, instead of only two, in which case the track 19 of the slide frame 17 must naturally be so dimensioned that one of the match plates according to the invention can cooperate with the mold-making machine, while a pattern change is effected on the other match plates during the operation of the molding machines.

According to another feature of the invention, the slide frame 14 can be used as a sliding die for the ejection of the respective finished sand molds from the mold-making machine.

It follows from the foregoing considerations that the match plate according to the invention in its various embodiments, or the match plate arrangement according to the invention in its various embodiments, particularly in combination with flaskless sand mold-making machines, allows not only a considerable acceleration of the pattern change, but also leads to an acceleration and trouble-free performance of the molding process proper. The match plate and match plate arrangement according to the invention particularly in combination with flaskless sand mold-making machines, makes a substantial contribution to increasing the economy of fully automatic casting plants.

The above described match plate according to the invention can be used not only in combination with mold making machines of the type described in this connection, but also generally in combination with semi-automatic or automatic mold-making machines. In this application too, it offers all the above-described advantages.

SECOND EMBODIMENT

In connection with FIGS. 16 to 18 of the drawings another embodiment of a sand mold production-and-conveyor plant according to the invention will be described. As far as parts are represented in these figures

which are identical with the parts represented in FIGS. 1 to 15, they have been provided with the same reference letters or reference numbers.

FIG. 16 shows just like FIG. 7 a side view a mold-making machine generally designated with 101, with an adjoining conveyer track for the finished molds, generally designated with 102.

The machine frame of the mold-making machine 101 if formed by the molding sand feeding device to be described later, particularly with reference to FIG. 18. The mold-making machine 101, like the mold-making machine described above with reference to FIG. 1 to 7, has a top die Ba, a bottom die Bb, and upper mold frame Ca and a lower mold frame Cb. The vertical displacement of the lower mold frame Cb is effected by a hydraulic drive, identical with the hydraulic drive Ea (FIGS. 1 to 7), which is not represented for clarity's sake in the drawings and which acts in opposite direction to Eb. The vertical displacement of the top die Ba is effected by means of a hydraulic drive Fa and that of the bottom die Bb by means of a hydraulic drive Fb acting in opposite direction. Preferably in the horizontal center between the two hydraulic drives Ea, Eb and Fa, Fb is fixedly mounted a horizontal guide 103 in which the match plate D designed as a truck is so guided that it can perform horizontal movements, but no vertical movements. The match plate D can have the form described above in connection with FIGS. 9 to 15 of the drawings.

In FIGS. 16 to 18 of the drawings, the mold-making machine 101 according to the invention is represented in an operating position in which the match plate D is in molding position and in which the upper mold frame Ca bears with its bottom edge and the lower mold frame Cb bears with its top edge on the top and bottom respectively of the match plate. In FIG. 18 the two press dies Ba and Bb are represented in the so-called filling position, that is, the top die is in topmost position and the bottom die Bb is in its bottommost position.

For reasons to be described more fully below, the hydraulic drives Fa and Fb serving for the vertical displacement of the two dies Ba and Bb with a preferably square horizontal cross section, and the two mold frames Ca, Cb cooperating with them, are designed as ring drives, that is, their press cylinder chambers 104 are preferably circular, and pistons 105 are guided therein which are connected by piston rod elements 106 with the associated die Ba or Bb.

Preferably the hydraulic drives Ea and Eb (the latter not being represented in the drawings) for the vertical displacement of the upper and lower mold frames Ca and Cb are designed as ring drives, as shown in FIG. 21 of the drawing, whose ring pistons 105', guided in ring-shaped cylinder chambers 104', are connected by corresponding piston rod elements 106' with the associated mold frames Ca and Cb respectively. These hydraulic drives for the vertical displacement of the two mold frames Ca, Cb can also have the form of regular hydraulic drives, as shown in FIG. 19 of the drawings, as they are used in combination with the mold-making machine shown in FIG. 1 to 7. Preferably two hydraulic drives units Ea and Eb are arranged diametrically opposed to avoid canting of the mold frames Ca and Cb.

In case the hydraulic drives Ea, Eb are designed as ring drives according to the preferred embodiment of the invention, their piston rod elements 106 can have preferably the form of hollow cylinders, which extend

to the outside through annular slots in the ring-shaped press cylinders arranged at the end face and designed as stuffing boxes, representing in this way as, so-to-speak, telescopic extensions of the cylindrical hollows formed by the radial inner walls of the ring cylinders. In case the hydraulic drives Ea and Eb of the mold frames Ca and Cb are also designed as ring drives according to FIG. 21, their piston rod elements 106' must be so designed and arranged, for example, as single rods, that a canting-free transmission of power from the circular ring pistons 105' with a circular horizontal cross section to the mold frames Ca and Cb, preferably with a square horizontal cross section, is ensured.

The guide 103 of the match plate D has its extension in guide rails 107 of a cross slide 108, which corresponds in principle to the cross slide described above in connection with FIG. 15 of the drawings, and whose cross guides are not arranged in this embodiment below the longitudinal guide rails 107, but designed as guide rails 109 suspended on the ceiling of the building in which the cross slide 108 is guided by means of rollers. FIG. 16 of the drawings shows another match plate D' in rest position, which is guided in the guide rails 107' of the cross slide parallel to the guide rails 107 and which can be used instead of match plate D by corresponding transverse displacement of the cross slide 108 along the cross rails 109.

The match plate guide 103 is designed in the preferred embodiment of the invention described here as a substantially gas-tight duct whose apertures at the end face, provided with corresponding frame packings 110, 111 are packed in molding position of the match plate by properly arranged stepped folds 112, 113 of this match plate.

The conveyer track for the finished mold train has in the preferred embodiment of a molding sand production and conveyer plant described here the form of a table-shaped oblong bench whose surface is formed of guides, spaced in the longitudinal direction, in the form of ledges 114 of wear-resistant material for the finished molds, for example, of steel or wear-resistant plastic, along with the finished mold ejected from the mold-making machine 101 slide with friction.

The conveyer track 102 for the finished mold train also houses the drive for the horizontal reciprocal movement of the match plate D, which will now be described in detail with reference to FIGS. 16, 17 and 20 of the drawings.

In longitudinal rails 115 of the conveyer track 102 for the mold train is guided a truck 116 which has two cross yokes 117 and 118. The cross-yoke 117 is engaged by piston rod 119 of a hydraulic drive whose press cylinder 120 is secured on the frame of the conveyer track 102 for the mold train. On cross-yoke 118 are secured at both sides fork elements 121 protruding over the conveyer track, whose respective free ends are hook-shaped and engage corresponding hook-shaped counter-elements 122 of the match plate D in such a way that they can on the one hand move the match plate back and forth along the longitudinal guide 103 of the mold-making machine 101 and along the longitudinal guide 107 of the cross slide 108 between their molding position and rest position, while permitting on the other hand, in the rest position of the match plate D a separation of the connection and transverse displacement of the match plate by corresponding transverse displacement of the cross slide 108. In guide 123

of the conveyer track frame for the mold train is guided another truck 124, on which are secured at both side of the conveyer track for the mold train upwardly protruding fork elements 125. The truck 124 has a cross-beam 126 on which is secured an axially displaceable follower element 127. This follower element 127 protrudes through a bore of the cross beam 118 of the truck 116 and establishes a connection between the fork-elements 121, on the one hand, and the sliding forks 125 on the other hand, permitting a certain idle run.

On the match plate D is preferably secured over an elastic intermediate element 128, a sliding die 128 in the form of a vertical plate which effects after completion of molding the ejection of the sand molds produced in the mold-making machine 101 during the reinsertion of the match plate D from its rest position into its operating position.

In the embodiment of the sand mold production and conveyer plant described here, a double-sided support of the finished molds produced in the mold-making machine 101 is provided during their advance along the conveyer track for the mold train. This is effected by supporting units which are generally designated by 128 and which will now be described in detail particularly with reference to FIGS. 16 and 20 of the drawings. The supporting units 128 have a trolley head formed of a weight 129 and roller bearings 130 secured thereon, as well as rollers 131, by means of which they can be moved along an overhead trolley conveyer rail 132 secured on the ceiling. This guide rail has according to the invention above at the point where the conveyer track 102 adjoins the mold-making 101, a rail section 134 which can be lowered, for example, by means of a hydraulic drive 133. A similar lowerable rail section (not shown) is arranged at the mold knock-out point. The weight 129 can be displaced along a vertical guide 135, which has at the top a stop 136 and which is secured with its bottom end on a weight-plate 137. On the weight plate 137 are secured bearing noses 138, in which are centrally supported two-arm levers 139 whose ends on one side are articulated on the weight 129 over toggle lever guide rods 140, and at whose other free ends, clamping plates 142 can be tilted by means of bearing noses 141 about horizontal bearing journals. The toggle lever connections 139, 140 are so dimensioned that, when the trolley head is suspended on the lowerable rail section 134, the clamping plates 142 are held in a spread position exceeding transverse dimension of finished molds 143, while, when the trolley head is released downward, the weight plate 137 bears on the surface of the respective finished mold 143 and pulls the weight 129 down along its guide 135, thus displacing the toggle lever mechanism 139, 140 so that the clamping plates 142 bear with a certain contact pressure on the two side plates of the respective finished mold 143, supporting the latter at both outer sides. FIG. 20 shows in the upper left half the toggle lever mechanism 139, 140 in spread position, and in the upper right half in pressing position.

In the embodiment of the sand mold production and conveyer plant according to the invention described here it is provided that the finished molds produced in the mold-making machine and ejected from the latter by reciprocal movement of the match plate D by means of the sliding die 128, form on the conveyer track 102 a continuous mold train within which the end faces of

the ejected finished molds 143 are supported by the clamping plates 142 only at the longitudinal flanks. According to a modified embodiment of the invention, not represented in the drawings, the respective finished molds 143 ejected from the mold-making machine 101 onto the conveyer track 102 are supported on all four sides, to which end the supporting units described above with reference to FIGS. 16 and 20 of the drawings are so modified that the clamping plates 142 are found on all four sides of the weight plate 137 in the manner described and represented above. In this case the train of finished molds 143 advancing along the conveyer track 102 is formed, which are each supported on all four sides by clamping plates 142 and whose respective adjacent end-faced clamping plates are in mutual contact.

At the bottom ends of the clamping plates 142 can be secured bearing journals 144 with guide rollers 145 which bear on corresponding outer guide faces 146 of the frames of the conveyer track 102, with the clamping plates 142 bearing on the finished mold 143. Furthermore, vertical protection strips 147 can be elastically secured for lateral movement at one end face of the clamping plates 142 serving for the lateral support of the finished molds 143, whose functions will be explained below.

As already pointed in connection with the description of the sand mold production and conveyer plant represented in FIGS. 1 to 8, the ejection of the respective finished mold is effected from the mold-making machine according to the invention in such a way that the respective ejected finished mold only has to absorb a fraction of the thrust that is necessary for advancing the finished mold train along the conveyer track. In this way the finished mold produced in the mold-making machine and ejected therefrom is not exposed to excessive thrusts and thus destroyed. In the embodiment of the sand mold production and conveyer plant described here, such a protection of the respective finished mold 143 ejected from the mold-making machine against destruction is achieved, on the one hand, by the above described idle gear mechanism 118, 126, 127, and on the other hand, by the fact that the individual finished molds 143 bear on each other with their edges inside the mold train only, with the clamping plates 142 supporting the two lateral faces, and that the sliding forks 125 of the hydraulic drive 119, 120 for the match plates engage the rear edges of the clamping plates 142 of the last supporting unit 128 placed on the respective last ejected finished mold 143. The elastic, laterally movable vertical strips of the clamping plates 142 of the supporting units 128 are arranged on the respective front edges of these clamping plates. The means spread of these vertical strips 147 is equal to the spread of the sliding forks 125. As it can be seen particularly from FIG. 17 of the drawings, the sliding forks 125 have the same trapezoidal cross section as the elastic, laterally movable vertical strips 147 of the clamping plates 142.

FIGS. 16 and 17 of the drawings show the plant in a state in which the match plate D is in molding position and the sliding die 128 of the match plate has just ejected a finished mold. This ejected finished mold 143 is not yet supported, but a supporting unit 128 has just arrived on the overhead trolley conveyer rail and is positioned on the lower rail section 134 of this overhead trolley. The piston rod 119 of the hydraulic drive 119, 120 is in the retracted state and consequently both the

follower fork elements 121 for the match plate D and the sliding forks 125 for the mold train are in their respective foremost position. If the hydraulic drive 119, 120 is now operated to extend its piston rod 119, the truck 116 and with the two follower forks 121 are moved to the rear so that the match plate D is pushed back along its guide 103 and along the guide 107 of the cross slide 108 into its rest position. After about 1/5th of this return path, the cross beam 118 of the truck 116 strikes against the crossbeam 126 of the truck 124 and the sliding fork 125 is thus also moved to the rear so that it arrives in the rear position represented in FIGS. 16 and 17 in broken lines. The hydraulic drive 133 is then operated to lower the rail section 134 of the overhead trolley guideway, so that the supporting unit 128, which hung before in ready position above the ejected finished mold 143, is now placed on the finished mole and assumes the position indicated in FIG. 16 in broken lines. The hydraulic drive 119, 120 is now operated to return the match plate D into molding position so that first the follower fork 121 and then, with a certain delay, the sliding forks 125 are moved ahead. The difference between the path covered by the follower fork 121 and that covered by the sliding fork 125 is so adjusted by means of the adjustable idle gear mechanism 127 that the advance of the sliding forks 125 begins when the front end face of the next finished mold, now ejected by the sliding die 128 of the match plate D from the mold-making machine 101, bears on the rear and face of the previously ejected finished mold now sheathed by the supporting unit 128. The vertical alignment of the lowerable rail section 134 of the overhead trolley and of the retracted position of the sliding forks 125, represented in FIGS. 16 and 17 by broken lines, is such that when the supporting unit 128 is lowered, the rear edges of the clamping plates 142 of this supporting unit are placed directly in front of the front edges of the sliding forks 125. Besides, the size of the clamping plate length plus the width of the vertical strips is substantially equal to the longitudinal dimension of the finished molds 143. The rear edges of the two clamping plates 142 of the respective last supporting unit represented in FIGS. 16 and 17 of the drawings by solid lines, are thus in front of the front edge of the sliding forks 125 represented in their rear position in these figures by broken lines, by the amount which corresponds to the length of a finished mold 143 and to the length of the clamping plates 142 plus the width of the vertical strips 147. The supporting unit over the finished mold 143 could thus place itself during the lowering by means of the hydraulic drive 133 exactly between the front edges of the sliding forks 125, shown in rear position by broken lines, and the rear edges of the clamping plates 142 of the last supporting unit 128 of the sheathed mold train, so that the clamping plates 142 of the last attached supporting unit 128 bear with their vertical strips 147 on the rear edges of the clamping plate 142 of the previous supporting unit 128 of the mold train. Since the vertical strips 147, as mentioned above, are secured elastically for lateral movement on the front edges of the clamping plates 142, they can balance minor inaccuracies so that it is ensured in any case that the thrust exerted by the sliding forks 125 on the mold train will be transmitted to the mold train, not over the respective last ejected finished mold 143, but by respective abutment of the front edges of the clamping plates 142 and of the vertical strips 147 on the mold

train. The clamping plates 142 of the supporting units 128 can be covered with the pins 148 represented in FIG. 20 of the drawings, which ensure a good transmission of the thrust from the vertical strips 147 arranged on the clamping plates 142. The complementary wedge angles of the terminal edges of the clamping plates 142 are preferably so selected that self-locking occurs so that, on the one hand, a positive transmission of the thrust from the supporting unit 128 to the next supporting unit 128 of the mold train is ensured and, on the other hand, a readjusting possibility by hand exists in case it is found that after a number of feed strokes any longitudinal differences have cumulatively added up and there is a danger at any point that gaps will form either between the normally juxtaposed end faces of the finished molds 143 and consequently the thrust-produced supporting effect on these surfaces ceases, or that excessive surface pressures appear at these surfaces. The gentleness of the thrust transmission between the hydraulic drive 119, 120, the finished molds 143, and the supporting units 128 is additionally improved at the start of the thrust by the fact that the sliding die 128, as mentioned above, is secured on the match plate D with the interposition of an elastic element 127. It can also be increased by placing a spring, bridging a short distance over the idle path, between the cross yoke 118 of the truck 116 and the idle gear mechanism connection 127. As indicated in FIG. 16 of the drawings on the right side, the design of the front edges of the clamping plates and vertical strips also permits the inclusion of finished molds of different height in the mold train advancing along the conveyer track 102. The height dimensions of the clamping plates 142 are geared to the greatest height dimensions of the finished molds 143, and the supporting units 128 are so designed, as it can be seen from FIGS. 16 and 20, that when lower finished molds are included in the mold train, the clamping plates 143 supporting the latter on both sides can protrude downward beyond the plane of the guide strips 114 of the conveyer track for the mold train, without hindering the advance of the mold train. This possibility, however, does not readily exist in the support of the finished molds 143 by the above mentioned modified embodiment of the invention. In this case supporting units 128 must be used which are provided with clamping plates of lower height dimensions, at least on the sides supporting the end faces of the finished molds.

MOLDING SAND

With regard to FIGS. 17 to 19 of the drawings, the arrangement for feeding the molding sand into the mold-making machine 101 of the sand mold production and conveyer plant according to the invention will now be described in detail. As mentioned above, the molding sand feeding device in the embodiment of the plant according to the invention represented in FIGS. 16 to 26 forms at the same time the frame of the mold-making machine 101. In contrast to the embodiment of the mold-making machine according to the invention described above with reference to FIGS. 1 to 8 of the drawings, the pneumatic feeding of the molding sand into the cavities of the mold frame is effected here with reference to the mold-making machine described in FIGS. 16 to 26 not from the side, but from the top and bottom through corresponding apertures in the two dies Ba, Bb.

A pressure pipe 149 of a compressor 150 is connected to a compressed air-tank 151, from which branch off an upper and a lower compressed air pipe 153a and 153b, each containing a control valve 152a and 152b respectively which opens into a molding sand tank 154 of the mold-making machine 101. This molding sand tank 154 consists substantially of a molding sand pipe 156a opening into an upper sand chamber 155a, a lower molding sand pipe 156b opening into a lower sand chamber 155b, and a connecting pipe 157 connecting these two molding sand pipes 156a and 156b with each other. At the top of the molding sand tank 154 is arranged a sand mold filling device, which will be described below more fully. The upper sand chamber 155a and the lower sand chamber 155b are formed by the ring cylinders of the hydraulic drives Fa and Fb respectively for the press dies Ba and Bb. As it can be seen particularly from FIG. 18 of the drawings, the entire molding sand tank 154 forms within the vertical center plane of the mold-making machine 101 a substantially C-shaped unit representing the machine frame, whose vertical legs are formed by the sand mold connecting pipe 157, while the two C-arcs are formed by the sand mold pipes 156a and 156b which hold at their respective opposing leg ends the hydraulic drives Fa, Fb for the press dies Ba, Bb and the hydraulic drives Ea, Eb for the mold frames Ca, Cb. The guide 103 for the match plate D is arranged substantially in the horizontal center plane of the C-construction, which is preferably designed as an air-tight duct as mentioned above, and which can be connected over a flap valve 159 represented in FIG. 17 to suction pipe 160 of the compressor 150 and over a flap valve 161, likewise represented in FIG. 17 and a branch pipe 162 to the pressure pipe 149 of the compressor 150 and to the compressed air collecting tank 151. Apertures 163 for the molding sand in the two press dies Ba, Bb of the mold-making machine have preferably the form of holes or slots with conical profile, the cone taper facing either the mold frame cavities, as shown in FIG. 18 or the sand chamber, as shown in FIG. 21. In the case of slots, the apertures 163 can be formed between rods traversing the respective press die in grate form. In the embodiment described here, the molding sand apertures 163 of the press dies Ba, Bb cannot be closed. In a variant of the invention, which is not represented in the drawings, these moldings sand apertures can also be provided with controlled or uncontrolled closures, the rods, in the case of slot-shaped apertures 163 formed between lattice-shaped rods being controlled by or uncontrolled by arranged for rotation about their longitudinal axes, so that they close in transverse position the molding sand apertures formed between them in the manner of louvers, while they form the above mentioned slots between them in vertical position. Both in the compressed air-pipes 153a, 153b and in the molding sand pipes 156a, 156b, 157 and in the molding sand chambers 155a, 155b can be arranged louvered baffle plates (not represented in the drawings).

The molding sand filling device 158 has as substantial components a hopper 164 connected with a sand bunker and molding sand conveyer track (not represented in the drawings), closing guide rails 165, a closing truck 166 guided in these guide rails and a closing plate 169 suspended on this closing truck and provided on its underside with a packing 168. This closing plate 169 co-

operates with its upper flange-shaped opening mouth-piece 170 of the molding sand tank 154, which is so arranged above the branching point of the upper molding sand pipe 156a between the upper sand chamber 155a and the molding sand connecting pipe 157, that, when the closure is opened the molding sand falling out of the hopper 154 is distributed uniformly in both directions. The closing truck 166 can be moved back and forth between an opening and closing position by means of a hydraulic drive 171. The guide rods 167 are preferably stressed by a torsion spring (not shown) that they turn the closing plate 169 in the direction of the closing movement of the hydraulic drive 171. This has the result that when the closing plate 169 strikes against stop 172 of the filler opening when reaching the closing position, it is pressed onto the flange of this opening in the manner of a toggle lever. This way a gas-tight trouble-free closing of the molding sand tank is ensured, which is particularly wear-resistant when the packing 168 of the closing plate 169 consists, for example, of a wear-resistant plastic, like TEFLON.

All walls of the molding sand feeding device that come in contact with molding sand, particularly all molding sand pipes and the two molding sand chambers 155a and 155b, are covered according to the invention preferably with exchangeable covers of wear-resistant molding sand-repellent material, for example, of TEFLON.

Instead of air it is of course possible to use any other suitable gas for the conveyance of molding sand, for example, nitrogen, if this should be advisable for some reason.

In the two press dies Ba and Bb can be provided, according to a further development of the invention, (not shown) vent holes on the sides facing the respective mold frame cavities, which terminate in die cavities which are in turn in communication over vent ducts with the outside atmosphere. The function of these vent holes and vent ducts is primarily to eliminate the air from the two mold frame cavities during the pneumatic introduction of molding sand into these mold frame cavities from the molding sand chambers 155a, 155b through the die apertures 163. In a variant, these vent holes and vent ducts can also be connected to the suction pipe 160 or pressure pipe 149; in the former case the elimination of air is improved, while in the latter case a slight detachment of the top and bottom surface of the finished mold the two press dies Ba and Bb is effected during the release of the finished mold at the end of the mold-making process before the ejection of the finished mold by the introduction of compressed air into these vent holes.

The design of the press die drives Fa, Fb as ring-shaped hydraulic drives whose cylindrical piston rod elements 106 form, together with the drives and the two plate shaped press dies Ba and Bb provided with apertures 163, the walls of the two molding sand chambers 155a, 155b. This represents a special embodiment of the mold-making machine according to the invention, since in this arrangement canting of the press dies Ba, Bb is practically impossible, and an important prerequisite for carrying out the process forming the subject of the invention is thus satisfied, namely maximum molding accuracy and angular accuracy of the finished mold 143. In a variation of the invention as illustrated in FIG. 27, a different embodiment of the invention than that represented in the drawings may be of impor-

tance under certain circumstances, where the two molding sand chambers 155a', 155b' of the mold-making machine 101 are bounded by normal cylindrical walls with cylindrical telescopic extensions, which latter are connected to plate-shaped, preferably square press dies Ba', Bb' in a top view, which are actuated by means of vertical hydraulic drives arranged above and below the molding sand pipes 156a', 156b' whose piston rods pass through the centers of the molding sand chambers 155a, 155b.

The two pneumatic control valves 152a, 152b can be so controlled by means of a control device that either both compressed air pipes 153a, 153b are simultaneously filled with compressed air from the compressed-air tank 151, or that there is a certain delay between the admission of air into the two compressed air pipes, the length of this interval being preferably adjustable. Such controls are familiar to the man skilled in the art and they are not represented in the drawings nor are they further described within the framework of this specification. In a variation of the invention, a single compressed air pipe branching off from a single control valve can be provided instead of the two compressed air pipes 153a, 153b branching off separately from the compressed air tank 151 with separate control valves 152a, 152b. This single compressed air pipe branching off behind this valve to open into the molding sand tank 154 of the mold-making machine 101 with two branches in the manner described with regard to the compressed air pipes 153a, 153b. Such a modified embodiment of the compressed air supply to the molding sand tank 154 according to the invention naturally does not permit individual control of the compressed air supply, on the one hand, to the upper molding sand chamber 155a and, on the other hand, to the lower molding sand chamber 155b of the mold-making machine 101, but only the simultaneous admission to the two molding sand chambers with compressed air.

As described above with reference to FIGS. 16 and 17 of the drawings, two match plates D and D' respectively can cooperate selectively with the mold-making machine 101 in connection with the cross slide 108 according to the invention. This has the advantage, as it was likewise pointed out, that, on the one hand, the mold-making machine can be operated with a match plate in the sense of the production of a certain mold series while on the other hand, the pattern change can be effected at the same time on the other match plate. FIG. 17 shows in its upper half the match plate D' ready for the pattern change in the half section, whose left half shows the top plate 9' with the pattern attached, according to the embodiment of the match plate described above with reference to FIGS. 9 to 14. The cross slide 108 is likewise only represented in half section in the left half of FIG. 17 so that only one of the two guide rails 109 for the slide can be seen. These guide rails 109 preferably extend to both sides of the mold-making machine 101, as can be seen from FIG. 17, so that the cross slide 108 can be moved to both sides with respect to the mold-making machine 101 in the manner represented in FIG. 15 of the drawings and one of the two match plates D or D' can be used selectively.

As it can likewise be seen from FIGS. 16 and 17 of the drawings, swivel arms 175 are provided on the cross slide 108 which carry infrared-radiators 176 by means of which the match plate D and D' can be heated from

the top and from the bottom as long as they remain in rest position. Such a match plate and pattern heating system facilitates the separation of the finished mold halves from the pattern. Heretofore the heating of the match plates has been effected from the inside. The external heating of the match plate and of the pattern halves placed thereon according to the invention has the advantage, compared to the customary internal heating, that it is much simpler in its design and that the infrared radiators 176 can be so adjusted in direction and distance, as is required by the respective pattern to be molded. Before each pattern change the infrared radiators 176 can be swung away by means of their swivel arms 175, so that they do not interfere during the operation on the match plate D and D'.

According to a modified embodiment of the invention, not represented in the drawings, two or more conveyor tracks 102 can be provided instead of a single one, which can be preferably displaced along guide rails laid on the ground transverse to their longitudinal direction. Such an arrangement permits one of the conveyor tracks for the mold train to be selectively brought into operative connection with the mold-making machine 101, thus reducing substantially the total time required for the production of the mold, the conveyance of the finished mold, the cooling of the cast molds, and the knocking out of the molds, while keeping the space required for accommodating the plant according to the invention relatively small.

SECOND EMBODIMENT OPERATION

Though the method of operation of the sand mold production and conveyor plant described with reference to FIGS. 16 to 21 corresponds in principle to that plant according to the invention described with reference to FIGS. 1 to 8, it will be described again briefly with reference to FIGS. 16, 18, 22 to 26 of the drawings. The details already represented in FIGS. 16 and 18 have been omitted for clarity's sake in FIGS. 22 and 23, and particularly in FIGS. 24 to 26.

FIG. 26 shows the arrangement in an operating position in which the last finished mold 123, produced by re-inserting the match plate D, has been ejected onto the conveyor track and connected to the mold train which is already there. The match plate D is in molding position and the upper and lower mold frame Ca and Cb respectively, and the top and bottom die Ba and Bb respectively, are in the upper limiting positions in which they permit the ejection of the finished mold 123 and the insertion of the match plate D with the pattern halves attached thereon. The same state is represented in FIG. 16, which also shows that supporting unit 128 is ready for the just ejected finished mold 123 to be subsequently lowered over this finished mold.

By means of the hydraulic drives Ea and Eb the mold frames Ca and Cb are now pushed until they strike against the top side and bottom side respectively of the match plate. The mold frame cavities are now ready for the pneumatic introduction of molding sand. This stage is represented in FIG. 18 of the drawings. During the first stage of the mold-making machine 101 it is necessary to first fill the molding sand tank 154, and to this end one of more "dry shots" must be fired. The supply of molding sand is effected by the hopper 164 of the molding sand feeding device with the filling slide valve 169 open. The entering molding sand spreads over the upper sand chamber 155a and the connecting pipe 157

and fills via the latter also a part of the lower molding sand pipe 156b and the lower compressed air pipe 153b. The approximate molding sand limit is indicated in the former by a broken line and in the latter by a solid line in FIG. 18. After the filling slide valve 169 is closed, the so-called "dry shot" is fired by opening the control valves 152a, 152b, that is, the compressed air accumulated in the compressed air tank 151 flows through the two compressed air pipes 153a and 153b into the molding sand tank 154 and forces the molding sand contained in the upper molding sand chamber 155a through the apertures 163 of the plate-shaped press die Ca, so that this mold frame cavity is filled. At the same time the compressed air supplied through the upper compressed air pipe 153a forces the molding sand contained in the connecting pipe 157 down into the lower molding sand pipe 156b, and the compressed air arriving through the lower compressed air pipe 153b forces in addition to the molding sand contained in the lower molding sand pipe 156b into the lower molding sand chamber 155b. If the lower molding sand chamber 155b is not yet completely filled with molding sand by such a first dry shot, molding sand is again supplied to the molding sand tank 154 through the molding sand filling device 158 and an additional dry shot is fired by which in all probability, not only the lower molding sand chamber 155b of the mold-making machine 101 is filled with molding sand, but the molding sand contained in the lower molding sand chamber 155b is also blown through the apertures 163 at the bottom die Bb into the cavity of the mold frame Cb. The molding sand tank 154 of the mold-making machine is now in a filling state, as it is indicated in FIG. 18 by the solid boundary lines and dots. Both in the firing of the dry shaft and in the firing of the so-called "filling shots", the match plate guide 103 of the mold-making machine 101, designed as a gas-tight duct, can be connected to the suction pipe 160 of the compressor 150 by opening the flap valve 159, so that the air contained in the cavities of the mold frames Ca and Cb is exhausted and the filling process enhanced. The air in these mold frame cavities flows through the bores 12 of the top and bottom plate of the match plate D not covered by the pattern halves into the interior of the match plate frame 1 and from there through the guide duct 103 and the flap valve 159 into the suction pipe 160 which leads to the compressor 150. After the filling of the two mold frame cavities with molding sand is completed, the flap valve 159 is closed again. The control of the control valves 152a, 152b is effected both in the dry shot and in the filling shot in such a way that the compressed air accumulated in the tank 151 enters the pressure pipes 153a and 153b in an explosion-like manner, which results in an abrupt movement of the molding sand inside the molding sand tank 154 of the mold-making machine 101 also filling abruptly of the mold-frame cavities of the machine.

The pressing of the mold halves can now start. To this end the hydraulic drives Fa and Fb of the top die Ba and of the bottom die Bb are so actuated that the two dies move relative to the two mold-frames Ca, Cb in the direction of the match plate D until the desired degree of solidification of the two mold halves has been achieved. This state is represented in FIG. 22 of the drawings.

By simultaneously operating the hydraulic drives Ea, Eb and Fa, Fb, the two mold halves are now removed

from the match plate D and from the pattern secured thereon, as shown in FIG. 23 of the drawings. This process can be further enhanced by connecting the duct-shaped match plate guide 103 of the mold-making machine 101 and thus the interior of the match plate D to the pressure pipe 149 of the air compressor 150 by opening the flap valve 161. The over-pressure built up in the interior of the match plate D passes through the match plate apertures 12 on the bottom and top surface of the upper and lower mold half and thus augments the separation process. The valve 161 is then closed.

The hydraulic drive 119, 120 of the conveyor track 102 is now operated so that the match plate D is pushed out of the mold-making machine 101 along its guide 103 and onto the guide 103 and onto the guide 107 of the cross slide 108 and thus into its rest position, in which it is heated by the infrared radiators. By operating the hydraulic drive 119, 120 the sliding fork 125 is also displaced with a certain time delay into a position indicated in FIGS. 16 and 17 by broken lines. The rail section 134 of the overhead trolley 132 can now be lowered by operating the hydraulic drive 133 so that the supporting unit 128 suspended thereon is attached over the ejected finished mold 143. The rail section 134 is lowered so far that it releases the trolley head with the weight 129, so that the weight plate bears on the surface of the finished mold 143 and at the same time the two clamping plates 142 bear on the two lateral faces of the finished mold 143. As soon as the match plate D has reached its rest position in the cross slide 108, a core can be inserted into a lower mold half either mechanically or by hand.

The finished mold is now in a state which permits the closing of the latter. To this end the hydraulic drives Ea, Eb, and Fa, Fb of the mold frames Ca, Cb and of the press dies Ba, Bb are operated simultaneously so that the two mold halves move toward each other until finally the state represented in FIG. 24 of the drawings has been reached. The finished mold 143 is now closed and is ready to be ejected from the mold-making machine 101.

Before it can be ejected, the finished mold must be released by the two mold frames Ca, Cb. This is effected by operating the hydraulic drives Ea, Eb in such a way respectively upward and downward until their bottom and top edge are flushed with the respective pressing surfaces of the two dies facing the finished mold.

The mold train passes by a casting pit along the conveyor track 102 where the mold that is in the casting pit is being cast. After passing through a certain cooling zone, the mold train arrives at the mold knock-out point where the casting or castings are knocked out from the mold and collected at a suitable point while the molding sand of the knocked out molds is fed to a used sand bunker to be processed again. As mentioned above, a rail section of the overhead trolley 132, which can be lowered in the manner of rail section 134, is arranged above the mold knock-out point of the conveyor track 102. The hydraulic drive of this lowerable rail section is so operated that the rollers of the trolley heads of the supporting units 128 of the finished molds 143 arriving at the mold knock-out point strike the lowered rail section. As soon as this is done, the respective hydraulic drive is operated to lift the lowerable rail section, so that the respective supporting unit 128 is now lifted from the respective finished mold 143 and fed to

the overhead trolley 132 to return again to the lowerable rail section 134 adjacent the mold-making machine 101. The cast finished mold at the knock-out point is therefore again free of its supporting unit 128 and can be easily knocked out.

The plant is now in the state shown in FIG. 25 of the drawings as far as the mold-making machine 101 is concerned.

Now the hydraulic drive 119, 120 of the conveyor track 102 is operated to again insert the match plate D into the mold-making machine 101. The just completed finished mold, which is in the mold-making machine, is pushed out onto the conveyor track 102. The molding sand lugs formed by sand formed in die apertures 163 still adhering to the finished mold 143 from the molding process are simply cut off without the finished mold being damaged in any way. The operation of the hydraulic drive 119, 120 in the sense of re-inserting the match plate D into the mold-making machine 101 and ejecting the just completed finished mold 143 from the mold-making machine also effects, with a certain time delay, the feed to the sliding fork 125, which now advances the entire mold train by the length of a finished mold along the conveyor track 102. The trolley head of the supporting unit 128 attached over the second to the last ejected finished mold thus runs out of the lowered rail section 134 of the overhead trolley 132, so that the rail section 134 can be raised again to the level of the overhead trolley 132 by operating the hydraulic drive 133 for the entrance of the supporting unit 128 returning from the mold knock-out point. As soon as this supporting unit 128 strikes the rail section 134, the plant is again in the state represented in FIGS. 16 and 26.

In connection with the description of the match plate according to the invention on the basis of FIGS. 9 to 15 of the drawings it has been mentioned that jarring devices are arranged on the match plate frame 1, preferably on all four sides. These jarring devices are naturally operated by the pattern halves secured on the match plate D, before the finished mold halves are removed, as it is generally the case in mold-making machines.

The above described operations are preferably controlled, as mentioned above, by a central control device which can be operated either hydraulically or electronically. Such program controls are known in the industry in many embodiments and require no inventive achievement for adaptation to the control of the above described operations of the sand mold production and conveyor plant according to the invention, so that the description and representation of such a control device can be dispensed with. It suffices merely to point out that the proper control of the various operations is effected preferably by limit switches in the proper order, a central control being provided, if necessary, by a programmer. That each operational step of the plant according to the invention can be controlled individually, if necessary, is obvious to the man skilled in the art.

As it results from the foregoing considerations, the invention relates to a method and apparatus which can be used for patterns of all kinds, in small and large quantities, and also for parts of small and large dimensions; and which can furthermore be automated in all its essential functions and therefore only require low investment and operating costs. The match plate according to the invention permits the changing of patterns if necessary, without interrupting the usual working cycle either on the extended match plate by the

quick-change elements according to the invention, or by trasverse displacement of a cross slide which carries both the just extended match plate and one or more additional match plates, of which one is used again. The

finished molds are supported either on two sides or on all sides by supporting elements, a continuous train of molds being formed preferably which is advanced in the cycle of the mold-making machine by the match plate entering the train, each supporting element entraining its respective mold. All inner surfaces of the mold frames are parallel to each other and right-angled to the match plate. The filling of the two mold frame cavities is effected by an explosion-like supply of air from the top and bottom, the air being supplied perpendicularly to the direction of conveyance of the sand, which is achieved by louvered baffle plates which determine the direction of the air flow before and during the impact on the molding sand, and the air is preferably exhausted simultaneously during the filling process through the match plate from the mold frame cavities to be filled. When removing the mold, compressed air is preferably supplied through the match plate to improve this operation. The universal quick pattern change is furthermore made possible by pattern units which can be secured easily and rapidly on the match plate provided with raster holes by combining sprue, feeder, gate etc. with the pattern to a firmly adhering unit. The pattern units may be magnetically secured as well. If the use of pattern units is not possible or not expedient, for example, in patterns with uneven division or in pattern of very large size, pattern-change plates or pattern change-partial plates can be used, which can likewise be provided with raster holes. A preferably U-shaped runner for the liquid metal is always arranged in the center and/or at the outer edges of the same point and thus facilitates the easy change of the pattern units and pattern units-partial plates on the same match plate, the width of this runner being constant, while the height is variable, except when the match plate is only equipped with pattern units, in which case it changes in its raster dimensions. By pivoting the match plate or individual parts thereof about a horizontal axis, the pattern change can be further accelerated. In order to avoid undesired clogging, the two mold halves can have at the edge of the separating joint complementary bev-els. The correction of unavoidable length differences between the finished mold ejected onto the conveyor track and the supporting units supporting the latter, can be effected, instead of by vertical strips with a wedge-shaped cross section, by threaded star wheel spacer pins which are set in action automatically when passing by a stop. The preferred design of the hydraulic drives for the press cylinders as ring drives has the additional effect that a very low overall height is obtained with a given stroke, so that the path which the molding and has to cover in the pneumatic feeding into the molding sand chambers is short. The piston elements of these hydraulic drives, which are preferably designed as ring pistons with cylindrical piston rod elements, can have in the latter bores for equalizing the pressure between the inner and outer walls. The plate-shaped press dies flanged on the piston rod-elements are preferably divided so that the above mentioned cavities are formed, which are in communication with the vent holes facing the mold cavities. The conical die apertures are preferably arranged symmetrically in large numbers and are at the same time relatively narrow in

order to avoid as far as possible consolidation of the sand and to achieve on the other hand, a particularly vertical direction of flow for the sand at all points of the match plate. This is important because of the substantially reduced wear of the patterns, which is relatively high if the sand moves transverse to the match plate. On the circumference of the press dies are preferably arranged exchangeable piston like strips, and on their sides facing the mold frame cavities are arranged preferably exchangeable perforated plates of wear-resistant material, preferably of polyamide B. The press dies are preferably square or rectangular and cooperate with equally shaped upper and lower mold frames. The inner walls of these mold frames are preferably exactly perpendicular to the press dies and match plate, so that, on the one hand, a satisfactory vertical adjustability of the mold cavities, and thus any variability in height of the finished molds can be achieved, and on the other hand, the conveyance method according to the invention is made possible. Preferably the insides of the mold frames are lined with exchangeable plates of wear-resistant material, so that their wear is within tolerable limits. The patterns used can likewise be provided with bores for the supply and discharge of air, just like the match plate. For packing the duct-shaped match plate guide of the mold-making machine can be used, for example, inflatable air sleeves. Since both ring pistons of the ring-shaped hydraulic drives have the same area dimensions and are operatively connected in parallel, there is always the same pressure at the same time in both cylinders, so that practically no reaction forces can be transmitted to the machine foundation. The molding sand to be introduced into the mold-making machine can be added by means of an electric sand feeler on the basis of sand level measurements. The sand is refilled after each mold production cycle by a single operational step of the plant. The pressure of the compressed air in the compressed-air system can be kept relatively low, which again helps to protect the patterns.

What I claim is:

1. A flaskless sand mold producing and conveying plant having

- a. a sand mold making machine comprising vertically moveable upper and lower mold frames, upper and lower dies respectively contained in said mold frames and capable of relative movement thereto, a hollow match plate having a series of apertures in its top and bottom surfaces for mounting patterns, said match plate having a top and bottom plate, said apertures extending to said top and bottom plates, said match plate being mounted for movement from a rest position laterally adjacent said sand mold making machine to an operative position between said mold frames and dies, and a pneumatic mold sand supply device;

- b. conveying means laterally adjacent said sand mold making machine;

- c. and supporting means bearing against at least two sides of a finished mold, the plant operating such that said match plate is clamped by said upper and lower mold frames to form mold cavities, said pneumatic mold sand supply device fills said cavities, said upper and lower dies compress said sand against said patterns to form a mold, said mold frames and dies are vertically moved from said match plate, said match plate is laterally moved to

said rest position, the so-formed mold is closed and when said match plate is returned to said operating position, the finished mold is ejected onto said conveying means and said supporting means are placed on said mold.

2. A flaskless sand mold producing and conveying plant having

- a. a sand mold making machine comprising substantially vertically movable upper and lower mold frames, upper and lower perforated dies respectively contained in said mold frames and capable of relative movement thereto, a match plate having patterns on the top and bottom surfaces thereof mounted for movement along horizontal guides from a rest position laterally adjacent said sand mold making machine to an operative position between said mold frames and dies, and an extendable sand chamber being arranged respectively above the upper and below the lower mold frame, each of said sand chambers being connected to a sand tank laterally arranged to said upper and lower mold frames, a filling device for said sand tank, and a pressure gas tank connectable by control valve means to each of said sand chambers;
- b. conveying means laterally adjacent said sand mold making machine opposite to the rest position of said match plate and being operatively connected with said match plate;
- c. and supporting means bearing against at least two sides of a finished mold and following the movements of said mold in cooperation with said conveyor means;

the plant operating such that said match plate is clamped by said upper and lower frames to form mold cavities, the mold sand is pneumatically filled into said cavities, said upper and lower dies compress said sand against said patterns to form a mold, said mold frames and dies are vertically moved from said match plate, said match plate is laterally moved to said rest position, the so-formed mold is closed and when said match plate is returned to said operative position the finished mold is ejected onto said conveying means and said supporting means are placed on said mold to go with it to a place near the knock-out place from where it returns to its starting place.

3. The plant as claimed in claim 1, including a match plate frame and, the hollow of said match plate being connectable selectively to a vacuum source and a pressure source.

4. The plant as claimed in claim 1, wherein said top and bottom plates are pivotally mounted on said match plate frame.

5. The plant as claimed in claim 3, wherein integer pattern units are mounted on the outer surfaces of said top and bottom plates, and in the case of the top surface said pattern unit includes an inlet, a feeder, an in-gate and the respective pattern half.

6. The plant as claimed in claim 1, wherein test plates having identical apertures and dimensions to said top and bottom plates of the match plate are provided to facilitate pattern changes and arrangements.

7. The plant as claimed in claim 2, wherein a cross-slide frame containing at least one extra match plate is provided adjacent said sand mold making machine so that while said sand match plate is in said rest position it may be exchanged with said extra match plate.

8. The plant as claimed in claim 1, wherein said match plate is moved along guide means between said rest and operative positions, said conveying means being on the opposite side of said sand mold making machine when in said rest position, said guide means being gas tight ducts, selectively connectable to a vacuum and a pressure source and said ducts communicating with said match plate hollow to evacuate or pressurize the same.

9. The plant as claimed in claim 2, wherein said conveyor means is a driven conveyor.

10. The plant as claimed in claim 9, wherein said conveyor is an endless steel belt.

11. The plant as claimed in claim 10, wherein said steel belt is driven when a pre-determined pressure is exerted by the last ejected mold.

12. The plant as claimed in claim 1, wherein a hydraulic drive is mounted below said conveyor means which acts by way of forked intermediate members on said match plate and by way of sliding forks on said supporting means of the second last ejected mold.

13. The plant as claimed in claim 12, wherein said forked intermediate member is attached to said match plate by a hook which allows relative lateral movement as well as raising said match plate relative to said hook.

14. The plant as claimed in claim 12, wherein said hydraulic drive is connected to said forked intermediate members and said sliding forks such that when said forked intermediate members bring said match plate from said rest position to said operative position thereby ejecting said finished mold, a predetermined delay exists before said sliding forks are actuated to move the second last ejected mold.

15. The plant as claimed in claim 14, wherein a spring buffer is arranged between said forked intermediate members and said sliding fork to cushion the thrust.

16. The plant as claimed in claim 2, wherein infra-red heaters are arranged above and below said rest position of said match plate to heat the same.

17. The plant as claimed in claim 2, wherein said supporting means are endless belts arranged laterally adjacent said conveyor means.

18. The plant as claimed in claim 2, wherein said conveyor means is an endless conveyor belt and vertical guides are laterally adjacent said belt, said supporting means of said finished mold comprising two horizontally pivoted clamping plates, which plate support the lateral sides of said finished mold.

19. The plant as claimed in claim 18, wherein said supporting means are lowered onto said finished mold after it is ejected from said mold making machine, and said clamping plates have at least one counter weight for the opening and the closing thereof.

20. The plant as claimed in claim 19, wherein said counter weight actuates said clamping plates by means of levers, said counter weight is connected to a trolley which in turn runs on a track between a knock-out station and a station adjacent said mold making machine where said supporting means is lowered over said ejected finished mold, as it is lowered said clamping plates are in a spread position exceeding the width of said mold, and a weight plate connected by said levers to said clamping plates and said counter weight abuts the top of said mold and actuates the closing of said spread clamping plates against said mold.

21. The plant as claimed in claim 18, wherein said supporting means for each finished mold has two pairs of said clamping plates for supporting all four sides.

22. The plant as claimed in claim 20, wherein each said clamping plate has a vertical strip on the side remote from said mold making machine, said vertical strip has a wedged shaped cross-section and is attached to said clamping plate to allow elastic lateral movement, the length of said clamping plate plus said vertical strip is substantially equal to the length of said finished mold in the direction of said conveying means.

23. The plant as claimed in claim 20, wherein said track has a section at said knock-out station and said station adjacent said mold making machine which are lowered by means of hydraulic devices.

24. The plant as claimed in claim 2, wherein said dies are actuated by a hydraulic piston and cylinder, and the piston rods connecting said die to each respective piston pass through said respective upper and lower sand chambers.

25. The plant as claimed in claim 2, wherein said upper and lower sand chambers are respectively defined by annular pistons and cylinders having a cylindrical connecting tube actuating each respective die.

26. The plant as claimed in claim 2, wherein said die apertures are truncated cones in vertical cross-section.

27. The plant as claimed in claim 2, wherein said die apertures are slots and elements in said slots are actuated like louvers.

28. The plant as claimed in claim 1, wherein said pneumatic mold sand supply device comprises a gas compressor, a pressure gas tank, a mold sand tank laterally arranged to said upper and lower mold frame, a filling device for said sand tank, at least one gas pressure line and valve between said pressure gas tank and said sand mold tank to admit gas and force the sand into said respective mold cavities through upper and lower sand chambers, there being two gas pressure lines and valves between said pressure gas tank and said mold sand tank, said upper and lower sand chambers and the mold sand tank forming a C in vertical cross-section, and said two gas pressure lines respectively enter at the upper and lower portions of the C.

29. The plant as claimed in claim 1, wherein said upper and lower dies have vents in their surfaces facing that mold cavities, which vents are in communication with die cavities, which in turn are selectively connected to vacuum and pressure sources.

30. The plant as claimed in claim 2, wherein said upper and lower mold frames are respectively hydraulically actuated by pistons and cylinders mounted laterally said annular pistons and cylinders.

31. The plant as claimed in claim 2, wherein said upper and lower mold frames are respectively hydraulically operated by concentric annular pistons and cylinders.

32. The plant as claimed in claim 28, wherein said two gas pressure lines branch off from a single pressure gas feed connected with said pressure gas tank and containing one valve.

33. The plant as claimed in claim 28, wherein said filling device consists of a hopper opening into the top of the sand tank, and a hydraulically operated horizontal slide valve consisting of a carriage movable in a horizontal guide and a horizontal cover plate fitted to said carriage by toggle levers to close the hopper entrance.

* * * * *